Prepared for:

Bailey Site Settlors Committee
GeoSyntec c/o Parsons Resident Engineering Science, Inc.
9906 Gulf Freeway, Suite 100
Houston, Texas

CONSTRUCTION QUALITY ASSURANCE PLAN

IMPLEMENTATION OF REVISED REMEDIAL DESIGN

BAILEY SUPERFUND SITE ORANGE COUNTY, TEXAS

Prepared by:

GeoSyntec Consultants
1100 Lake Hearn Drive, NE, Suite 200
Atlanta, Georgia 30342

Project Number GE3913-528

February 1997

800022

TABLE OF CONTENTS

1. INTRODUCTION 1-1

1.1 Overview 1-1

1.2 CQA Plan Scope 1-1

1.3 CQA Plan Organization 1-2

1.4 Related Plans 1-3

2. CQA PLAN DEFINITIONS 2-1

2.1 Construction Quality Assurance and Construction Quality Control 2-1

2.2 Earthwork 2-1

2.3 Geosynthetics 2-2

2.4 Erosion Control 2-2

2.5 Wastewater Treatment 2-3

3. PERSONNEL ORGANIZATION 3-1

3.1 Owner 3-1

3.1.1 Definition 3-1

3.1.2 Responsibilities 3-1

3.2 Regulatory Agency Oversight 3-1

3.2.1 Definition 3-1

3.2.2 Responsibilities 3-1

3.3 Construction Manager 3-2

3.3.1 Definition 3-2

3.3.2 Responsibilities 3-2

3.4 Resident Engineer 3-3

3.4.1 Definition 3-3

TABLE OF CONTENTS (continued)

3.4.2 Responsibilities 3-3
3.5 Field Technician 3-4
3.5.1 Definition 3-4
3.5.2 Responsibilities 3-4
3.6 Quality Assurance (QA) Officer 3-5
3.6.1 Definition 3-5
3.6.2 Responsibilities 3-6
3.7 Contractor 3-6
3.7.1 Definition 3-6
3.7.2 Responsibilities 3-6
3.8 Soils CQC Laboratory 3-7
3.8.1 Definition 3-7
3.8.2 Responsibilities 3-8
3.9 Geosynthetic CQC Laboratory 3-8
3.9.1 Definition 3-8
3.9.2 Responsibilities 3-9
3.10 Wastewater CQC Laboratory 3-9
3.10.1 Definition 3-9
3.10.2 Qualifications 3-9
3.10.3 Responsibilities 3-10
3.11 Geosynthetics Manufacturers 3-10
3.11.1 Definition 3-10
3.11.2 Responsibilities 3-10
3.12 Geosynthetics Installer 3-11

TABLE OF CONTENTS (continued)

3.12.1 Definition 3-11
3.12.2 Qualifications 3-11
3.12.3 Responsibilities 3-12

4. DOCUMENTATION 4-1

4.1 Daily Recordkeeping 4-1
4.1.1 Daily Summary Reports 4-1
4.1.2 CQA Monitoring Logs and Test Data Sheets 4-2
4.1.3 Problem Identification and Corrective Measures Report 4-3
4.2 Photographic Documentation 4-4
4.3 Design and/or Construction Specification and Drawing Changes 4-5
4.4 Non-conformances 4-5
4.5 Remedial Action Report 4-5

5. CONSTRUCTION QUALITY ASSURANCE ACTIVITIES 5-1

5.1 Introduction 5-1
5.2 Review of Contractor Submittals 5-1
5.3 Surveying 5-2
5.4 Pre-Construction Activities 5-2
5.5 Construction Activities 5-3
5.6 Record Drawings and As-Built Surveys 5-4
5.7 Field Equipment Decontamination 5-5
5.8 Deficiencies 5-5
5.9 Documentation 5-6

TABLE OF CONTENTS (continued)

6. EARTHWORK CONSTRUCTION QUALITY ASSURANCE 6-1

6.1 Introduction 6-1

6.2 Components 6-1

6.3 Related Construction Specifications 6-1

6.4 Earthwork - General 6-2

6.5 Site Grading 6-3

6.6 Waste Material Removal and Relocation 6-3

6.7 General Fill 6-4

6.8 Aggregate 6-6

6.9 Riprap 6-7

6.10 Protective Soil Layer 6-8

6.11 Construction Monitoring 6-9

6.11.1 Test Methods 6-9

6.11.2 Test Frequency 6-10

6.12 Documentation 6-11

7. GEOSYNTHETIC CLAY LINER QUALITY CONTROL AND ASSURANCE 7-1

7.1 Introduction 7-1

7.2 Related Project Specifications 7-1

7.3 Transportation, Handling, and Storage 7-1

7.4 Conformance Testing 7-2

7.4.1 Sampling Procedures 7-2

7.4.2 Testing Procedure 7-3

TABLE OF CONTENTS (continued)

7.4.3 Test Results 7-3
7.4.4 Conformance Test Failure 7-3
7.5 Surface Preparation 7-4
7.6 Placement 7-4
7.7 Overlaps 7-5
7.8 Repair 7-5

8. GEOMEMBRANE CONSTRUCTION QUALITY CONTROL AND ASSURANCE 8-1

8.1 Introduction 8-1
8.2 Related Project Specifications 8-1
8.3 Transportation, Handling and Storage 8-1
8.4 Conformance Testing 8-2
8.4.1 Sampling Procedures 8-2
8.4.2 Testing Procedures 8-3
8.4.3 Test Results 8-3
8.4.4 Conformance Test Failure 8-3
8.5 Subgrade Surface Preparation 8-4
8.6 Anchorage Trench 8-4
8.7 Geomembrane Placement 8-5
8.7.1 Field Panel Identification 8-5
8.7.2 Field Panel Placement 8-5
8.8 Field Panel Seaming 8-7
8.8.1 Panel Layout 8-7
8.8.2 Seaming Equipment and Products 8-7

TABLE OF CONTENTS (continued)

8.8.3 Seam Preparation 8-7
8.8.4 Trial Seams 8-7
8.8.5 Nondestructive Seam Continuity Testing 8-8
8.8.6 Destructive Testing 8-9
8.9 Defects and Repairs 8-12
8.9.1 Identification 8-12
8.9.2 Repair Procedures 8-12
8.9.3 Verification of Repairs 8-12

9. GEOTEXTILE, GEOCOMPOSITE, AND GEOGRID CONSTRUCTION QUALITY CONTROL AND ASSURANCE 9-1

9.1 Introduction 9-1
9.2 Related Project Specifications 9-1
9.3 Geotextiles 9-1
9.3.1 Transportation, Handling and Storage 9-2
9.3.2 Conformance Testing 9-3
9.3.3 Placement 9-3
9.3.4 Seams and Overlaps 9-3
9.3.5 Repair 9-3
9.3.6 Placement of Soil Materials 9-4
9.4 Geocomposites 9-4
9.4.1 Transportation, Handling and Storage 9-4
9.4.2 Conformance Testing 9-6
9.4.3 Placement 9-8
9.4.4 Seams and Overlaps 9-8

TABLE OF CONTENTS (continued)

9.4.5 Repair 9-8
9.4.6 Placement of Soil Materials 9-8
9.5 Geogrids 9-9
9.5.1 Introduction 9-9
9.5.2 Related Project Specifications 9-10

10. GAS VENTING SYSTEM 10-1

10.1 Components 10-1
10.2 Conformance Testing 10-1
10.3 Installation 10-2
10.4 Repair 10-2

11. EROSION CONTROL CONSTRUCTION QUALITY ASSURANCE 11-1

11.1 Introduction 11-1
11.2 Related Project Specifications 11-1
11.3 Erosion and Sediment Control 11-1
11.3.1 Silt Fencing in Areas Subject to Inundation 11-1
11.3.2 Silt Fencing in Areas Not Subject to Inundation 11-2
11.3.3 Silt Fencing Within Removal Areas 11-2
11.3.4 Erosion Control During Construction 11-2
11.3.5 Erosion Control Following Completion of Cap 11-3
11.4 Site Clearing and Grubbing 11-3
11.5 Revegetation 11-3
11.5.1 Components 11-3
11.5.2 Installation 11-4

TABLE OF CONTENTS (continued)

12. WASTEWATER TREATMENT QUALITY ASSURANCE 12-1

12.1 Introduction 12-1

12.2 Related Project Sections 12-1

12.3 Wastewater Management System 12-1

12.3.1 Components 12-1

12.3.2 CQC Testing 12-2

12.3.3 System Start-Up 12-2

12.3.4 System Operation 12-3

12.4 Consolidation Water Collection System 12-4

12.4.1 Components 12-4

12.4.2 CQC Assurance 12-4

12.4.3 Installation 12-4

12.4.4 System Operation 12-5

13. AIR MONITORING QUALITY ASSURANCE 13-1

13.1 Air Monitoring 13-1

13.2 Air Monitoring for Worker Health and Safety Exposure 13-1

1. INTRODUCTION

1.1 Overview

This Construction Quality Assurance (CQA) Plan describes the quality assurance (QA) and construction quality control (CQC) activities that will be undertaken during construction of the Revised Remedial Design (RRD) for the Bailey Superfund Site Orange County, Texas. The purpose of this document is to define the scope, formal organization, and procedures necessary to ensure the project objectives are attained. This plan addresses the CQA and CQC activities to be performed by the Engineer during construction of the RRD.

The Bailey Superfund Site CQA Plan addresses the following elements of the RRD construction:

- general earthwork;
- geosynthetics;
- erosion control; and
- wastewater collection and treatment.

The quality assurance and quality control monitoring and testing procedures, along with the required frequency of tests, are provided in this CQA Plan. Also detailed in this plan are the organization of the QA personnel and other key parties to be involved in the RRD as well as the minimum standards for construction testing and documentation to ensure quality.

1.2 CQA Plan Scope

The CQA Plan establishes the quality assurance and quality control procedures and monitoring requirements to be implemented during construction of the RRD. The CQA Plan was developed to conform to relevant U.S. Environmental Protection Agency (USEPA) guidance. The scope of the CQA Plan includes:

- defining the responsibilities of parties involved with the RRD;
- providing the means for ensuring that the facilities constructed conform to the specifications and construction drawings;
- establishing procedures for construction documentation;
- providing guidance in the proper construction of cover system components; and
- establishing testing protocols for the evaluation of earthwork and cover system components.

The CQA Plan is intended to give guidance to the CQC Engineer during the construction of the RRD and to supplement the construction specifications for the Revised Remedial Design. In the case of any conflicts between the CQA procedures described in this plan and the requirements of the project specifications, the specifications will govern.

1.3 CQA Plan Organization

The remainder of this CQA Plan is organized as follows:

- other plans related to this CQA Plan are summarized in the remainder of Section 1;
- the definitions of key terms are presented in Section 2;
- the project organization, definitions and responsibilities of key parties involved with the RRD are presented in Section 3;
- the requirements for CQC documentation are described in Section 4;
- the CQA general activities for construction oversight, are presented in Section 5;
- the CQC activities for the general earthwork are presented in Section 6;

- the CQC activities for geosynthetic clay liner installation are presented in Section 7;
- the CQC activities for geomembrane installation are presented in Section 8;
- the CQC activities for geotextiles, geocomposites, and geogrid installation are presented in Section 9;
- the CQC activities for the installation of the gas venting system are presented in Section 10;
- the CQC activities for erosion control are presented in Section 11;
- the CQC activities for wastewater management and treatment are presented in Section 12; and
- the CQC activities for air monitoring are presented in Section 13.

1.4 Related Plans

Key documents (and revisions thereof) related to the CQA Plan include, but are not limited to the following.

- *Quality Assurance Project Plan for the Revised Remedial Design and Remedial Action (QAPP)*, dated September 1996, prepared by GeoSyntec Consultants.
- *Focused Feasibility Study Report, Revision 1, Bailey Superfund Site, Orange County, Texas (FFSR)*, dated September 1996, prepared by GeoSyntec Consultants. The FFSR proposed alternative remedies for the North Dike Area and East Dike Area. The alternative remedial design (ARD) presented in the FFSR includes the construction of a lightweight composite cap over the North Dike Area and East Dike Area. This alternative was used as the basis of the development of the RDD.

- *Work Plan for the Revised Remedial Design*, dated May 1996, prepared by GeoSyntec Consultants. This document outlines the development of the RRD.

- *Revised Air Monitoring Plan for Final Remediation*, dated September 1996, prepared by Parsons Engineering Science.

The construction documents for the RDD for the Bailey Superfund Site, Orange County, Texas, consist of:

- *Construction Specifications*, Revised Remedial Design, Bailey Superfund Site, Orange County, Texas, dated September 1996, prepared by GeoSyntec Consultants; and

- *Construction Drawings, Revised Remedial Design, Bailey Superfund Site, Orange County, Texas*, dated September 1996, prepared by GeoSyntec Consultants.

The contract agreement for the implmentation of the RDD for the Bailey Superfund Site, Orange couty, Texas are contained in:

- *Bid Documents, Contract Agreement, General Conditions, Revised Final Remediation, Bailey Disposal Site, Orange County, Texas*, dated 3 September 1996, prepared by Parsons Engineering Science.

2. CQA PLAN DEFINITIONS

2.1 Construction Quality Assurance and Construction Quality Control

In the context of this document, construction quality assurance and construction quality control are defined as follows:

- *Construction Quality Assurance (CQA)* - The planned and systematic means and actions employed by the Engineer to ensure adequate confidence that materials and/or services meet contractual and regulatory requirements of the RRD construction and installation with the project specifications and drawings.

- *Construction Quality Control (CQC)* - Those actions taken by the Engineer, Contractor, Subcontractor, Manufacturer, or Installer to ensure that the materials and the workmanship meet the requirements of the construction specifications and drawings.

2.2 Earthwork

Earthwork is the general term applied to all soils construction for the RRD. The term includes:

- excavation and removal of waste material;

- relocation and placement of waste material;

- placement of general fill to achieve grade for protective cap;

- placement of aggregates materials for various components;

- placement of riprap for slope erosion protection;

- placement of protective soil layer to protect geosynthetics and support revegetation;

- establishment of vegetation; and
- construction of final access roads.

2.3 Geosynthetics

Geosynthetics is the generic term for all synthetic materials used in geotechnical engineering applications; the term includes geotextiles, geocomposites, geogrids, geomembranes, and geosynthetic clay liners (GCLs). There are five types of geosynthetic products referenced in this CQA Plan which are included in the cover system. These geosynthetics include:

- smooth high density polyethylene (HDPE) geomembranes used in the composite cap;
- GCL's used in the composite cap;
- geocomposites used in cap construction to provide a drainage and gas venting layer;
- geotextiles used in the consolidation water collection trench, gas venting system sumps, and to provide slope protection by acting as a cushion/separator for the riprap; and
- geogrid used for the construction of the final access road on the cap.

2.4 Erosion Control

Erosion control is the general term used in the CQA plan to refer to :

- installation of silt fences for all applications during the construction activities;
- precautions taken to minimize the run-off from the work areas;
- maintenance of silt fences until adequate revegetation is established;

- installation of silt fences, perimeter berms, temporary surface dikes, and other erosion control measures required during site clearing and grubbing; and
- establishment of an adequate vegetation growth in areas disturbed by construction activities.

2.5 Wastewater Treatment

Wastewater treatment is the general term used in this CQA Plan to refer to:

- storm-water runoff collection and treatment of other waters which may come into contact with waste;
- consolidation water collection trench as well as consolidation water collection trench water treatment; and
- sampling frequencies.

3. PERSONNEL ORGANIZATION

3.1 Owner

3.1.1 Definition

In this CQA Plan, the term Owner will refer to the Bailey Site Settlors Committee (BSSC). The term Owner does not imply ownership of the site property, but is the term used to designate the entity who is requiring the Work to be performed.

3.1.2 Responsibilities

The Owner is responsible for funding and ensuring completion of remediation at the Bailey Superfund Site as directed by the Consent Decree. The Owner has the authority to approve all modifications, change orders, and Subcontractors.

3.2 Regulatory Agency Oversight

3.2.1 Definition

The regulatory agency for this site is the U.S. Environmental Protection Agency (USEPA). The regulatory agency will provide an on-site oversight representative to monitor construction activities.

3.2.2 Responsibilities

The regulatory agency oversight representative is responsible for observing site construction activities to ensure the regulatory agency that the construction activities are being performed as specified in the construction specifications and drawings for the RDD. The representative reports directly to the USEPA and has no responsibilities to other parties involved with this project.

3.3 Construction Manager

3.3.1 Definition

The Construction Manager shall be responsible for site operations and overall management of the construction. In this CQA Plan, the term Construction Manager shall refer specifically to the Construction Manager's Site Manager, or employees of his firm. The Construction Manager is the person, firm, or entity named by the Owner who will act as the Owner's representative and assume and perform all duties, responsibilities, rights, and authorities assigned to the Construction Manager in the Contract Documents. For this project, Parsons Engineering Science, Inc. (Parsons ES) has been designated as the Construction Manager.

3.3.2 Responsibilities

The Parsons ES Construction Manager shall be responsible for field management services including data acquisition and reporting as well as contractor coordination.

The Construction Manager is responsible for:

- authorizing and verifying materials entering and leaving the site;
- reporting directly to the Parsons ES Project Manager;
- coordinating Wastewater CQC Laboratory testing and review of Contractor submitted data packages; and
- authorizing additional CQC/CQA laboratory testing requested by Resident Engineer.

3.4 Resident Engineer

3.4.1 Definition

The Resident Engineer is the on-site representative of the Engineer. The Engineer is the person, firm, or entity named by the Owner who will act as the Owner's representative and assume and perform all duties, responsibilities, rights, and authorities assigned to the Engineer in the Contract Documents. For this project, GeoSyntec Consultants (GeoSyntec) has been designated as the Engineer. GeoSyntec is the consultant responsible for the RDD. The Engineer's Project Manager is responsible for coordinating the Engineer's site activities, assigning appropriate project personnel, monitoring budgets, schedules, and other contract related issues.

The Resident Engineer will report to the Engineer's Project Manager. The Resident Engineer will also report daily to the Construction Manager. In this CQA Plan, the term Resident Engineer shall refer specifically to the on-site representative, or other individuals acting on behalf of the Engineer.

3.4.2 Responsibilities

The Resident Engineer is responsible for:

- documenting construction progress and coordinating modifications to the design with the Construction Manager to accommodate actual conditions encountered;
- clarifying any discrepancies between the construction specifications and drawings, and field conditions;
- consulting with the Construction Manager on approval of alternative materials or construction methods proposed by the Contractor;
- coordinating testing and reporting of results from both the Soils and Geosynthetics CQC Laboratories;

- working closely with the QA Officer to ensure that quality assurance/quality control (QA/QC) data is collected and coordinated properly;
- directing and overseeing all activities performed by the Field Technician; and
- reporting all results to the Parsons ES Project Manager Parsons ES Construction Manager and GeoSyntec Project Manager.

The Resident Engineer may also be delegated the responsibilities of the Project Health and Safety Officer to evaluate the appropriate level of personal protective equipment and be responsible for the Engineer's field team operations and safety.

3.5 Field Technician

3.5.1 Definition

The Field Technician is an individual who conducts CQA and CQC testing on-site under the direct supervision of the Resident Engineer. For this project, the Field Technician will be a representative of GeoSyntec Consultants. The Resident Engineer may, at his option, subcontract the services of a Field Technician employed by a materials testing laboratory or engineering firm.

3.5.2 Responsibilities

The duties of the Field Technician include monitoring and documenting construction of all soils and geosynthetic components of the RRD. The Field Technician will perform these CQA activities and report the results to the Resident Engineer.

The duties of the Field Technician include, but are not limited to:

- monitoring material stockpiles for any deterioration of materials;

- monitoring surface-water drainage in the areas of soil and geosynthetic material stockpiles;
- preparing daily field reports;
- reporting problems to the Resident Engineer;
- assisting with collection of samples from the constructed soil components in accordance with this CQA Plan;
- monitoring soil placement and compaction operations;

The Field Technician will also be responsible for CQC activities related to the installation of the geosynthetic components of the RRD. The CQC activities include, but are not limited to:

- recording CQC activities on field logs;
- monitoring the unloading and on-site handling and storage of the geosynthetics;
- monitoring geosynthetic material deployment and installation operations;
- monitoring geosynthetic repair operations; and
- collecting conformance samples for testing by Geosynthetic CQC Laboratory.

3.6 Quality Assurance (QA) Officer

3.6.1 Definition

A Quality Assurance (QA) officer may be designated by the Engineer's Project Manager. The QA Officer will be an individual responsible for oversight of the QA/QC activities required for the RRD.

3.6.2 Responsibilities

The QA Officer is responsible for management of all aspects of QA/QC as required for construction. The QA Officer is also responsible for data validation. The QA Officer may delegate these responsibilities to other members of the project team.

3.7 Contractor

3.7.1 Definition

The Contractor is the firm or corporation responsible for constructing all aspects and components of the Bailey Superfund Site RRD. The Contractor is represented on-site by a qualified individual who is authorized to act on behalf of the Contractor in all matters pertaining to the construction of the RRD. The Contractor's field representative shall have the authority to direct and instruct the Contractor's crews and lower-tier Subcontractors.

3.7.2 Responsibilities

The Contractor is responsible for all construction activities and materials. The Contractor is also responsible for scheduling and coordinating the required work with its Subcontractors to complete the project within the construction schedule approved by the Construction Manager. The Contractor shall provide an experienced supervisory representative at all times during any construction activity on site. The Contractor is responsible for furnishing as-built record drawings and a copy of all documentation required by the construction specifications of the RRD for the Bailey Superfund Site. The Contractor is also responsible for updating all construction drawings for any deviations from the original construction specifications and drawings on a daily basis.

The Contractor's field representative is responsible for coordinating and supervising the work of all Subcontractors on site. At a minimum, the Contractor's field representative will be responsible for the following:

- assigning and supervising a Quality Control Technician;
- informing the Construction Manager of any discrepancies between the construction specifications and drawings and the field conditions;
- distributing all documentation required by the project specifications in a timely manner;
- attending all project coordination meetings held on site;
- scheduling all phases of the construction;
- maintaining a daily log of all construction activities on site;
- implementing and verifying all QC procedures required of the Contractor and/or Subcontractors; and
- submitting proposed materials or construction methods to the Construction Manager for approval prior to acquisition and use.

3.8 Soils CQC Laboratory

3.8.1 Definition

The Soils CQC Laboratory is the party, independent from the Construction Manager and Contractor, responsible for conducting geotechnical laboratory tests in accordance with standards referenced in the construction specifications and drawings, and this CQA Plan. The testing results generated by the Soils CQC Laboratory shall be used by the Resident Engineer and QA Officer to verify compliance of the soil construction materials with the construction specifications and drawings and submittals previously approved by the Construction Manager. For this project the Engineer has designated that the soils CQC laboratory will be GeoSyntec's Geoenvironmental Laboratory.

The Contractor shall also employ a Soils CQC Laboratory to conduct field and laboratory geotechnical tests in accordance with the standards referenced, and

frequencies designated, in the construction specifications and drawings and this CQA Plan. Testing results shall be available for review by the Resident Engineer.

3.8.2 Responsibilities

The Soils CQC Laboratory will be responsible for testing various soils components of the RRD. These tests shall include, but not be limited to, material qualification (conformance) tests and material construction quality control (performance) tests as described in construction specifications and drawings. The Resident Engineer will be responsible for coordinating the Soils CQC Laboratory testing program.

3.9 Geosynthetic CQC Laboratory

3.9.1 Definition

The Geosynthetic CQC Laboratory is the party, independent from the Construction Manager, Contractor, and Geosynthetics Manufacturer and Installer, responsible for conducting tests on samples of geosynthetic materials used in construction of the RRD in accordance with standards referenced in the, construction specifications and drawings, and this CQA Plan. The testing results generated by the Geosynthetic CQC Laboratory shall be used by the Resident Engineer and QA Officer to verify compliance of the geosynthetic materials with construction specifications and drawings and submittals previously approved by the Construction Manager. For this project, the Engineer has designated that the Geosynthetic CQC Laboratory will be GeoSyntec's Geosynthetic Materials Testing Laboratory.

The Geosynthetic CQC Laboratory will perform the conformance evaluation testing of the various geosynthetic components of the RRD and the performance testing required during construction, such as destructive seam testing.

3.9.2 Responsibilities

The Geosynthetic CQC Laboratory will be responsible for testing various geosynthetic components of the cover systems. These tests shall include, but not be limited to, geosynthetic conformance tests and destructive testing of the geomembrane field seams as described in the construction specifications and drawings. The Resident Engineer will be responsible for coordinating the Geosynthetic CQC Laboratory testing.

3.10 Wastewater CQC Laboratory

3.10.1 Definition

The Wastewater CQC Laboratory is the party, hired by the Contractor, responsible for conducting treated wastewater sampling analysis to determine if the wastewater has constituents/parameters less than those specified in the Site Sampling and Monitoring Plan and this CQA Plan. The testing results generated by the Wastewater CQC Laboratory shall be used by the Contractor and the Construction Manager to verify compliance of the treated wastewater with the plans, construction specifications, and submittals previously approved by the Construction Manager.

3.10.2 Qualifications

The Wastewater CQC Laboratory will be experienced in testing of constituents and parameters for contaminated water samples similar to those expected in the treatment of the wastewater from the Bailey Superfund Site according to the treatment standards referenced in the Site Sampling and Monitoring Plan. The Wastewater CQC Laboratory will be capable of providing test results within a maximum of 3 days of receipt of the samples and will maintain that capability throughout the duration of the project.

Prior to construction, the Wastewater CQC Laboratory shall submit their qualifications and QA/QC procedures to the Construction Manager for review and approval. The qualifications presented by the Wastewater CQC Laboratory shall, as a minimum, include:

- corporate background and statement of qualifications;
- list of testing capabilities including reference to EPA test methods;
- a laboratory QA/QC plan;
- information on staff size and experience; and
- information regarding test result turnaround time and reporting format.

3.10.3 Responsibilities

The Wastewater CQC Laboratory will be responsible for testing the treated wastewater for various constituent levels and parameters as specified in the Site Sampling and Monitoring Plan and this CQA Plan. The Contractor shall be responsible for coordinating the Wastewater CQC Laboratory.

3.11 Geosynthetics Manufacturers

3.11.1 Definition

The Geosynthetics Manufacturers are the firms or corporations responsible for production of the geosynthetic materials to be used in construction of the RRD. These materials include geosynthetic clay liner, geomembrane, geotextiles, geocomposites, and geogrid.

3.11.2 Responsibilities

Each Geosynthetics Manufacturer is responsible for the production and quality control of its respective geosynthetic product. In addition, each Geosynthetics Manufacturer is responsible for the condition of the geosynthetic until the material is accepted by the Contractor. Each Geosynthetics Manufacturer shall produce a consistent high quality product which shall meet all the requirements of the construction specifications and drawings. Each Geosynthetics Manufacturer shall submit quality

control documentation to the Contractor for its respective products. The Contractor will then submit QC documentation submittals to the Construction Manager as required by the construction specifications.

3.12 Geosynthetics Installer

3.12.1 Definition

The Geosynthetics Installer will be experienced and qualified to install the geosynthetic materials of the type specified for this project. The Geosynthetics Installer will be approved and/or licensed by the appropriate Geosynthetics Manufacturer. In accordance with the construction specifications, a copy of the approval letter or license will be submitted by the Contractor to the Construction Manager.

3.12.2 Qualifications

The Geosynthetics Installer shall meet the qualifications outlined in Section 02277 of the construction specifications.

The Geosynthetics Installer will designate one representative as its supervisor, who will be responsible for acting as the Geosynthetics Installer's spokesperson on site. The supervisor will be qualified by experience and shall have previously supervised the installation of at least 5,000,000 ft^2 (464,500 m^2) of polyethylene geomembrane using the same materials and seaming apparatus as to be used for the RRD.

The Geosynthetics Installer will provide the Construction Manager with a list of proposed seaming personnel and their qualifications. This document will be reviewed by the Resident Engineer. Final approval of the Geosynthetic Installers seaming personnel will be the responsibility of the Construction Manager. Any proposed seaming personnel deemed insufficiently experienced will not be accepted.

At least one seamer shall have experience seaming a minimum of 1,000,000 ft^2 (92,900 m^2) of polyethylene geomembrane using the same type or types of seaming apparatus to be used for this project. The most experienced seamer, the "master

seamer", shall provide direct supervision, as required, over less experienced seamers. No field seaming shall take place without the master seamer being present. The Geosynthetics Installer personnel responsible for performing seaming operations will be qualified with at least 100,000 ft^2 (9,290 m^2) of polyethylene geomembrane seaming experience using the same seaming methods as those required for the RRD.

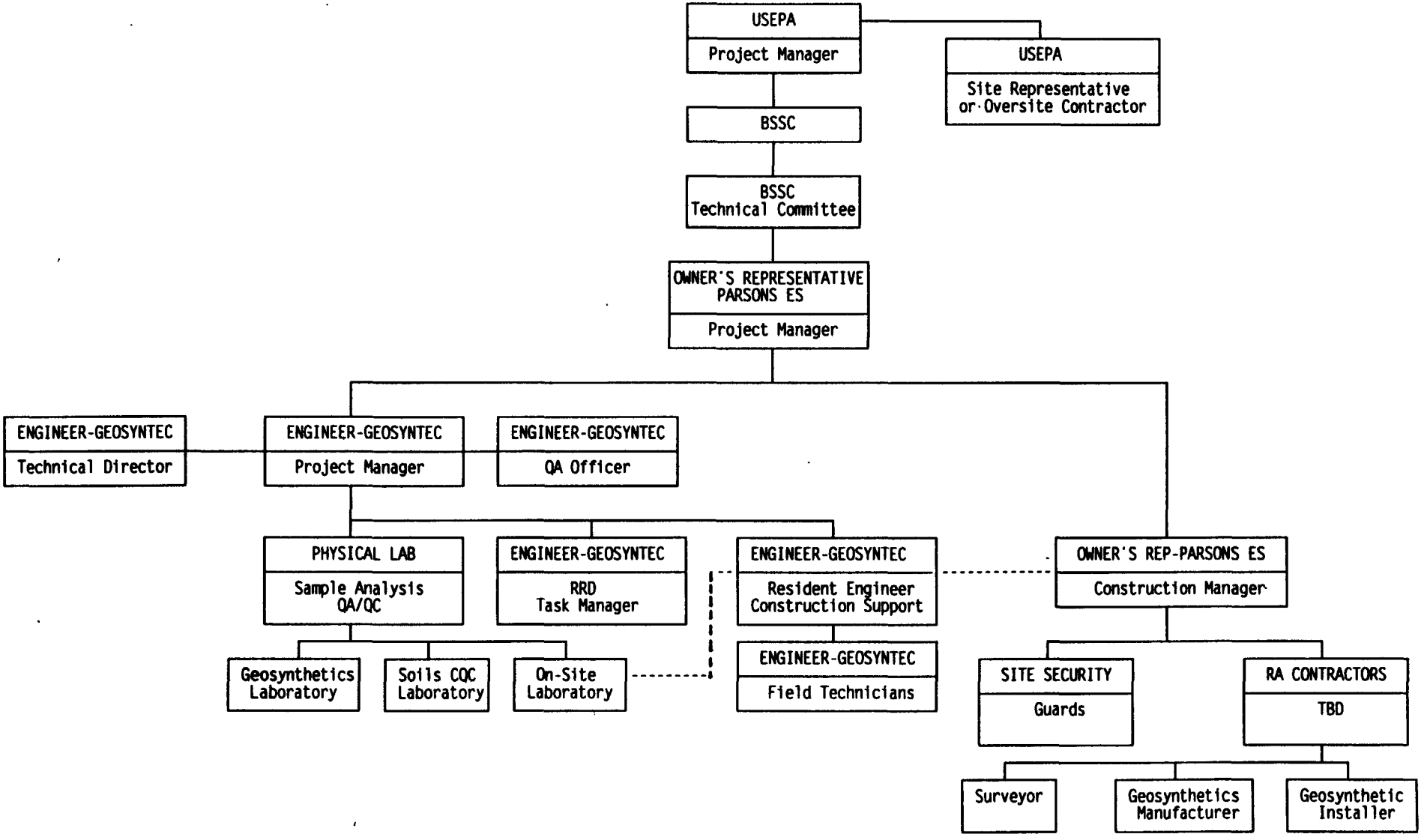
3.12.3 Responsibilities

The Geosynthetics Installer's supervisor will be responsible for handling installation of the geosynthetics used in construction of the RRD and for providing supervision and guidance to the installation crew. The Geosynthetics Installer's supervisor is also responsible for the following:

- obtaining samples, as required by this CQA Plan and the specifications;
- field testing;
- documenting quality control testing activities; and
- coordinating the geosynthetics installation activities with the Construction Manager.

The Geosynthetics Installer's supervisor will be responsible for documenting the geosynthetics installation activities, including, but not limited to, on-site personnel, material inventories, production figures, test results, installation deficiencies, and resolution of construction problems.

FIGURE 3-1
ORGANIZATION CHART
REVISED REMEDIAL DESIGN
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS



4. DOCUMENTATION

An effective CQA Plan depends largely on recognition of all construction activities that should be monitored and the assignment of responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance and quality control activities. The Resident Engineer will be responsible for ensuring that the Contractor's quality control requirements have been addressed and satisfied.

The Resident Engineer will provide the Construction Manager descriptive daily field reports, data sheets, and logs which document that monitoring activities have been performed. Examples of some of the forms which will be used to document CQC activities are included in Appendix A. The Resident Engineer will also maintain at the job site a complete file of the construction specifications and drawings, this CQA Plan, the Contractor's Quality Control Plan(s), checklists, test procedures, daily logs, and other pertinent construction, CQC and CQA documents. The files to be maintained will include the tasks discussed in the following sections.

4.1 Daily Recordkeeping

Standard reporting procedures will include preparation of daily CQA documentation which, at a minimum, will consist of: (i) daily summary reports (ii) monitoring logs; (iii) testing data sheets; and (iv) when appropriate, problem identification and corrective measures reports.

4.1.1 Daily Summary Reports

The Resident Engineer's daily summary reports will include the following information as applicable:

- date, project name, location, and other pertinent project identification;
- data on weather conditions;

- summary on meetings held and their results;
- process description(s) and location(s) of construction underway during the time period covered by the report;
- description of locations where tests and samples were taken;
- a narrative summary of field test results;
- off-site materials received, including quality control documentation;
- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard testing results;
- problem identification and corrective measures reports used to substantiate the decisions described above;
- signature of the respective Resident Engineer and/or the Field Technician; and
- photographs of site activities being monitored.

Corrections to the Daily Summary Reports shall be single line crossed out, initialed by the correcting personnel, and dated.

4.1.2 CQA Monitoring Logs and Test Data Sheets

Monitoring observations, sampling information, and test results will be recorded on appropriate monitoring logs and test data sheets. The Resident Engineer will use the monitoring logs and test data sheets to ensure completeness of the required CQC activities. Any corrections to the monitoring logs and test data sheets will be single line crossed out, initialed by the CQC personnel responsible for the correction, and dated. Examples of relevant monitoring logs are presented in Appendix A.

The CQC monitoring logs and test data sheets will include the following information as applicable:

- project specific information such as project name and location;
- the date the CQC activity was performed;
- description or title of the CQC activity or test procedure (reference to standard method when appropriate);
- location and sample increment of the CQC activity;
- recorded observation or test data, with all necessary calculations;
- results of the CQC activity and comparison with specification requirements (pass/fail); and
- the initials or signature of personnel involved in CQC inspection activity.

4.1.3 Problem Identification and Corrective Measures Report

A problem is defined herein as material or workmanship that does not meet the requirement(s) of the construction specifications and drawings. Problems identification and corrective measures reports should be cross-referenced to specific summary reports, logs, or test data sheets where the problem was identified. The reports should include the following information as applicable:

- detailed description of the problem;
- location of the problem;
- probable cause;
- how and when the problem was located;
- estimation of how long problem has existed;
- suggested corrective measure;

- documentation of problem resolution and correction (reference to inspection data sheets);
- final results;
- suggested methods to prevent similar problems; and
- signature of the appropriate CQC Field Technician and concurrence by the Resident Engineer.

In some cases, not all of the above information will be available or obtainable. However, when available, such efforts to document problems could help to avoid similar problems in the future. The Resident Engineer will distribute copies of the report to the Construction Manager for further actions.

4.2 Photographic Documentation

The Contractor will be responsible for obtaining photographic documentation of the Contractor's activities, materials installation methods, and testing procedures as specified in Section 01380 of the construction specifications. The Resident Engineer will also take photographs of the Contractor's activities being monitored for inclusion in the Remedial Action Report. Photographs will serve as a pictorial record of work progress, problems, and corrective measures. Photographic reporting data sheets should be utilized to organize and document photographs taken during construction. Such data sheets could be cross-referenced or appended to summary reports, CQC monitoring logs, or test data sheets and/or problem identification and corrective measures reports. At a minimum, photographic reporting data sheets should include the following information:

- an identification number on photographs;
- the date and location where the photograph was taken; and
- location and description of the work.

Color prints shall be organized chronologically and kept in a permanent protective file. Negatives shall be stored in a separate protective file.

4.3 Design and/or Construction Specification and Drawing Changes

Design and/or construction specification and drawing changes may be required during construction. These changes include requests for substitutions of materials. In such cases, the Contractor must submit written requests for changes or substitutions to the Construction Manager who will provide the requests to the Resident Engineer. The Resident Engineer will review and respond to these requests in a timely manner. In the case of substitutions, the Resident Engineer will be satisfied that all design criteria has been met and material quality is acceptable. Design and/or construction specification and drawing changes will be made only with the agreement and written authorization of the Construction Manager and the Resident Engineer. Such changes will take the form of an amendment to the construction specifications and drawings and must be in writing.

4.4 Non-conformances

The Construction Manager will be made aware of any significant recurring non-conformance with the construction specifications and drawings, or CQA Plan by the Resident Engineer. The cause of the nonconformance will be evaluated by the Resident Engineer. The Contractor will be directed by the Construction Manager to make appropriate changes in materials or procedures to correct the non-conformance. When this type of evaluation is made, the results will be documented, and any revision to procedures, construction specifications and drawings must be approved by the Construction Manager.

4.5 Remedial Action Report

At the completion of construction phases, the Resident Engineer will submit a construction phase final report to the Construction Manager to be incorporated into the Final Remedial Action Report for the site. This report will acknowledge that the work

has been performed in compliance with the construction specifications and drawings and physical sampling and testing has been conducted at the appropriate frequencies. The report will also include the necessary supporting information.

At a minimum, this report will include:

- summaries of CQA/CQC activities performed by the Engineer;
- CQA/CQC monitoring logs and testing data sheets including sample location plans;
- laboratory test results;
- problem identification and corrective measures reports;
- a descriptive summary of any changes from design and material specifications; and
- a summary statement indicating compliance with construction specifications and drawings which is signed and sealed by the Engineer.

The Contractor's record drawings, which include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.), and geomembrane panel record drawings will be submitted separately by the Contractor to the Resident Engineer for review. Once review comments have been addressed, the Contractor shall submit record drawings to the Construction Manager.

5. CONSTRUCTION QUALITY ASSURANCE ACTIVITIES

5.1 Introduction

During the construction of the Revised Remedial Design, the Contractor shall be responsible for making submittals on materials required for construction so the Resident Engineer can evaluate whether the materials meet the requirements of the construction specifications and drawings. During construction, the Contractor is responsible for providing CQC testing for the various components. This CQA Plan details those activities to be performed by the Resident Engineer to substantiate that the work performed was in compliance with the construction specifications and drawings. The Resident Engineer will be responsible for performing construction quality control activities for several construction components, which are discussed in Section 7, 8, and 9 of this Plan.

5.2 Review of Contractor Submittals

The Resident Engineer will review all Contractor submittals for materials to be used in the construction. The submittals shall be made to the Construction Manager, who shall in turn provide copies to the Resident Engineer for review and comment. The Resident Engineer will provide written responses to the submittals and return them to the Construction Manager who will transmit them to the Contractor. The Construction Manager will be responsible for receiving, logging, and filing all submittals. The Resident Engineer will be responsible for evaluating whether all required submittals have been made and approved prior to use of the material.

The Resident Engineer will review the Contractor's CQC Plan for adequacy. Adjustments may be required to this CQA Plan based on the level of testing and monitoring proposed by the Contractor. The Resident Engineer will also review, on a regular basis, the Contractor's CQC records for completeness and that they are maintained up to date.

5.3 Surveying

The Contractor is required to provide a surveying crew to set construction stakes, determine grades and limits of construction, as well as provide record drawings and as-built surveys. During construction, the Resident Engineer will perform the following activities related to the surveying tasks:

- review notes on tie-ins to survey monuments and control points;
- review field location of clearing limit stakes in accordance with the construction drawings;
- review field location of alignment stakes in accordance with the construction drawings; and
- review methods of determining grades for subgrade, cover components and anchor trench.

5.4 Pre-Construction Activities

Prior to any earthwork being performed that disturbs areas containing waste, the Resident Engineer will verify the following:

- erosion and sediment controls are in place prior to site clearing and grubbing activities;
- stormwater diversion ditches/berms are in place; and
- wastewater collection system, holding tanks, conveyance system, and treatment system are in operating condition.

5.5 Construction Activities

The Resident Engineer will observe the following construction activities. These general activities are in addition to the CQA and CQC testing activities described in more detail in subsequent sections of this document:

- rough site grading activities to check that waste material is maintained 1-ft (0.30 m) below the synthetic cap layer;
- proof-rolling activities following rough grading; if soft areas are detected, notify the Construction Manager and recommend whether placement of geogrid reinforcement layers or stabilization with lime would be adequate;
- excavation activities for the surface-water drainage pipe on the north side of the East Dike Area; if water is flowing outside the pipe, require the entire pipe to be removed;
- grouting operation of surface-water drainage pipe and capping of end after grouting; and
- delivery of materials and equipment to the site and method of storage.

During the installation of the various components of the RDD, the Resident Engineer will visually observe and document the Contractor's installation procedures. For earthwork related activities, the Resident Engineer will monitor for the following:

- changes in soil consistency;
- thickness of lifts as loosely placed and as compacted;
- soil conditioning prior to placement including general observations regarding moisture distribution, clod size, etc.;
- action of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc.);
- number of passes used to compact each lift;

- presence of desiccation cracks or ponded water; and
- final lift or layer thickness.

Performance testing shall be conducted during the course of the work. The minimum construction performance tests and frequencies are presented in the following sections. The frequency may be increased at the discretion of the Resident Engineer and upon the approval of the Construction Manager. Additional testing for suspected areas shall be considered when:

- variability in materials is observed;
- lift thickness is greater than specified;
- earthfill is at improper and/or variable moisture content;
- it is suspected that less than the specified/required number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- rollers may not have used optimum ballast;
- the degree of compaction is doubtful;
- the work area is reduced;
- adverse weather conditions have been experienced;
- equipment is not in prime operating condition; and
- frequency of failing test results increases.

5.6 Record Drawings and As-Built Surveys

During the construction of the soil components, the Resident Engineer will routinely review record drawings and as-built surveys submitted by the Contractor. The

drawings are used to verify location of work, percent of work completed, layer thickness, or final grades. Prior to the placement of successive soil or geosynthetic layers, the Resident Engineer will review certified as-built surveys which indicate compliance of the preceding layer thickness, lines, and grades. Once an as-built survey has been reviewed, the Resident Engineer will notify the Construction Manager of any discrepancies or non-compliance's observed. The Construction Manager will notify the Contractor of any non-compliance.

5.7 Field Equipment Decontamination

All equipment and vehicles used to relocate waste materials shall be decontaminated as shall the field equipment used in the sampling and testing of soils known or suspected of containing contaminated waste. The decontamination facilities shall be designed to isolate contamination, prevent cross contamination, prevent contamination from leaving the site, and be large enough to contain run-off and spray water. The decontamination of equipment shall be conducted in accordance with Section 01595 of the construction specifications.

5.8 Deficiencies

If a defect is discovered, or a component of the construction does not comply with the construction specifications and drawings, the Resident Engineer will evaluate the extent and nature of the defect in a timely manner. If the defect is indicated by an unsatisfactory test result, the Resident Engineer will evaluate the extent of the deficient area by additional tests, observations, a review of records, or other means that the Resident Engineer deems appropriate. If the defect is related to adverse site conditions, such as wet conditions, the Contractor shall correct the situation and rework or replace the affected material. The Resident Engineer will define the limits of the deficiency that must be corrected. The Resident Engineer will notify the Construction Manager of the defect as soon as possible, but in no case later than 24 hours after being made aware of the condition.

The Resident Engineer will verify that the Contractor has corrected all noted deficiencies to the satisfaction of the Resident Engineer and Construction Manager. If a

specified criterion cannot be met, or unusual weather conditions hinder work, the Contractor shall submit suggested solutions or alternatives to the Construction Manager for review. At locations where the field testing indicates in-situ conditions do not comply with the requirements of the construction specifications and drawings, the failing area shall be reworked to the satisfaction of the Resident Engineer and Construction Manager.

5.9 Documentation

The documentation of the field CQA testing activities is an important factor in ensuring the successful construction, performance, and approval of the Final Remedial Action Report for the RDD. The CQA monitoring observations, sample location descriptions, field test results, and laboratory test results will be documented by the Resident Engineer on forms similar to the examples included in Appendix A. Reports and forms shall be submitted to the Resident Engineer by the Field Technician on a daily and/or weekly basis as requested.

6. EARTHWORK CONSTRUCTION QUALITY ASSURANCE

6.1 Introduction

CQA monitoring and testing shall be performed during installation of the various earthwork components. Criteria to be used for determination of acceptability of the various components are identified in the project specifications and this CQA Plan.

6.2 Components

There are several components of earthwork construction for the RRD. The components included in the construction are:

- excavation, relocation, and placement of waste material;
- placement of a graded general fill layer over the waste material to provide a uniform surface for placement of the geosynthetics and grade to provide a slope to the cap for stormwater control;
- placement of a protective soil layer approximately 1-ft (0.30-m) thick to protect the geosynthetics from ultra-violet radiation and temperature extremes;
- establishment of a vegetation layer (selected grasses) on the protective soil layer and other disturbed areas to limit erosion;
- placement of aggregate and gravel for the consolidation water collection trench, gas venting system and the final access roads; and
- placement of riprap for slope erosion protection.

6.3 Related Construction Specifications

The following construction specification sections should be referenced by the Resident Engineer for pertinent earthwork, materials physical properties, and construction requirements:

- Section 01050 - Surveying;
- Section 01400 - Contractor Quality Control Plan;
- Section 02200 - Earthwork;
- Section 02274 - Riprap
- Section 02280- Geogrids;
- Section 02505 - Final Access Road;
- Section 02930 - Revegetation;
- Section 13030 - Waste Material Removal and Relocation; and
- Section 13070 - Consolidation Water Collection System.

6.4 Earthwork - General

Prior to the start of earthwork operations, the Resident Engineer will review the submittal information required by Section 02200 of the construction specifications. Compliance of the submittals with the construction specifications will be evaluated by the Resident Engineer and reported to the Construction Manager.

The Field Technician will monitor the placement of general fill and protective soil. If defective conditions are found to exist (i.e., damage by excess moisture (causing softening) insufficient moisture (causing desiccation and shrinkage), or by freezing), the Resident Engineer will evaluate the suitability of the subject soil layer by the following methods as applicable:

- moisture/density testing;
- continuous visual inspection during proof-rolling;

- checking the consistency of cohesive soils using a penetrometer, hand-held vane shear device, or other suitable field expedient measurement device in suspect weak soil areas; and/or

- other tests identified in Table 5-1.

6.5 Site Grading

Site grading may be required (especially in the East Dike Area) to grade the existing ground to permit the placement of a minimum of 1-ft (0.30 m) of general fill prior to the construction of the composite cap. Grading shall be performed to achieve the grades shown on the construction drawings. Following completion of rough grading, but prior to placement of relocated waste or general fill, the entire surface (excluding dike sideslopes) beneath the composite cap shall be proofrolled. Proofrolling shall consist of a minimum of three passes with a 2 ton (minimum) pneumatic tire roller. The Resident Engineer will observe proofrolling and identify any areas that pump or rut to a depth equal to or greater than 2 in. (50.8 mm) after multiple compactor passes. Unacceptable areas shall be modified by treatment or placement of geogrid reinforcement as specified in Section 02200 and 02280 of the construction specifications. No field density or moisture content testing is required of the subgrade materials.

6.6 Waste Material Removal and Relocation

Waste material removal and relocation shall be performed in accordance with Section 13030 of the construction specifications. The Resident Engineer will monitor the waste excavation, relocation and placement in designated areas as shown on the drawings. The actual horizontal and vertical limits of waste excavation shall be determined in the field by the Construction Manager. Only contaminated soils shall be excavated and relocated. The determination of contaminated soils will be based on visual observation by the Construction Manager. Prior to such determination, USEPA will be notified to allow for the USEPA on-site representative to be present. No verification testing of the residual soils for the presence of contaminants will be performed.

The Resident Engineer will observe the placement of the excavated waste material in areas requiring fill. The relocated waste material shall be placed and spread into maximum loose lifts of 6 in. (15.3 cm) by track dozers and compacted by repetitive tracking by the dozer. Each lift shall receive a minimum of four passes. If field observations indicate that the material contains a high moisture content or can not be compacted to achieve an equivalent density of 95 percent of the maximum dry density as determined by ASTM D-698, the material will be reworked or amended as specified in Section 13030 until adequate compaction can be achieved. No field density or moisture content tests are required for relocated waste material. Adequate compaction will be based solely on the visual observation and the sole interpretation of the Resident Engineer. Acceptance of the layer of waste by the Resident Engineer is required prior to placement of any subsequent layers or material. If it becomes necessary to dispose waste off site, it will only be performed following receipt of USEPA approval.

6.7 General Fill

General fill, as specified in Section 02200 of the construction specifications, will be placed over all relocated and in-situ contaminated material for a minimum thickness of 1-ft (0.30 m) prior to placement of the GCL layer, or in other areas to achieve subgrade elevations as shown on the construction drawings. General fill will be imported to the site. Contractor shall perform the following CQC testing of the imported soil at a frequency of one set of tests for every 2,000 cubic yards delivered to the site from each borrow source, or for each change in material:

- soil classification (ASTM D 2487);
- organic content (ASTM D 2974);
- moisture-density relationship (ASTM D698);
- particle-size analysis (ASTM D 422); and
- liquid and plastic limit (ASTM D 4318).

The Resident Engineer may obtain samples of the imported material for additional CQA testing at a greater frequency if deemed necessary by the Resident Engineer and

approved by the Construction Manager. Contractor shall also provide evidence to Construction Manager that a representative sample of each soil from each borrow source has been tested using USEPA SW846 test methods for constituents contained in the USEPA target compound list (TCL) and target analyte list (TAL).

The Resident Engineer will perform CQA testing of placed and compacted soil to evaluate compliance with the construction specifications and drawings. At a minimum, the dry density and moisture content of the soil will be measured using one of the following methods at the testing frequency given in Table 6-1:

- nuclear method (ASTM D2922);
- sand-cone method (ASTM D1556);
- drive cylinder method (ASTM D2937);
- moisture content by microwave oven (ASTM D3017); and
- moisture content by oven (ASTM D2216).

General fill shall be placed in loose lifts of 8 to 9 in. (203.2 to 228.6 mm) thick and compacted to a nominal thickness of 6 in. (152.4 mm). Contractor shall compact each lift to at least 95 percent of the soil's maximum dry density as measured in accordance with ASTM D698 and the moisture content not exceeding three percentage points above the optimum moisture content unless approved by the Resident Engineer. If the field density and moisture content tests indicate that fill material does not meet the compaction and moisture requirements of the project specifications, the material shall be reworked to meet specifications, retested by the Resident Engineer, or removed from the project. All required field density and moisture content tests will be completed before the overlying lift of soil is placed. Any required preparation of the soil lift (e.g., wetting, drying, scarification, etc.) will be completed before the Resident Engineer will allow placement of subsequent lifts.

Should compaction to the required moisture and density not be reasonably achieved for lower lifts of general fill, the Resident Engineer may reduce the compaction requirement to no less than 90 percent of the maximum dry density as determined by ASTM D698 for the soils at depths greater than 1-ft (0.30-m) below GCL.

All penetrations of the general fill within 1-ft (0.30-m) of the GCL resulting from field testing or surveying activities (density probe locations, survey stakes, etc.), shall be backfilled with soil or a soil-bentonite mixture immediately following the test. Excavations in the general fill due to construction activities shall be backfilled in 6-in. (152.4-mm) maximum lifts and compacted as previously specified. Testing of these areas shall be conducted at the discretion of the Resident Engineer.

6.8 Aggregate

Aggregate material for the consolidation water collection trench and the gravel subbase for access roads shall be salvaged road aggregate currently stockpiled on site or salvaged from existing on site access roads. Material shall be visually inspected for deleterious materials and shall be relatively clean of fine-grained material, organic material, trash, and debris. The amount of fine-grained material (amount passing a #40 sieve) shall not exceed 20 percent by weight. No testing is required for this material unless the amount of fine-grained material is questionable. If a sufficient volume of material is not available, the aggregate shall comply with the requirements for gravel base material as specified in Section 02200 of the project specifications.

Aggregate material for the gas venting system and the gravel base for the access roads shall consist of clean, hard, durable crushed stone, crushed gravel, or other suitable material free of any metals, roots, trees, stumps, concrete construction debris, organic matter, or deleterious materials. Material shall meet the gradation requirement for a No. 4 aggregate as specified in ASTM D 448.

Contractor shall perform sieve analysis (ASTM C 136) testing of the imported aggregate at a frequency of one set of tests for every 1,000 cubic yards delivered to the site from each borrow source, or for each change in material:

The Resident Engineer may obtain samples of the imported aggregate material for CQA testing at a greater frequency if deemed necessary by the Resident Engineer and approved by the Construction Manager. Contractor shall also provide evidence to Construction Manager that a representative sample of each aggregate from each borrow source has been tested using USEPA SW846 test methods for constituents contained in the USEPA target compound list (TCL) and target analyte list (TAL).

The Resident Engineer will perform CQA observation of the placed and compacted aggregate. No field density or moisture content testing is required for the aggregate material. Aggregate material shall be placed in maximum compacted thickness of 6 in. (152.4 mm). Placement shall be made in a manner that avoids segregation. Uncontrolled spreading shall not be permitted. For roadways, aggregate materials shall be compacted by multiple passes with a smooth drum vibratory roller or other suitable equipment.

The frequency of CQA testing shall conform to the minimum frequencies presented in Table 6-1. The frequency of testing may be increased at the discretion of the Resident Engineer and upon the approval of the Construction Manager.

6.9 Riprap

Riprap, as specified in Section 02274 of the construction specifications, will be placed around the perimeter of the cap area in selected locations as shown on the construction drawings. Typically, the riprap will be placed to a thickness of 12 in. (30.6 cm). The method of placement will be proposed by the Contractor and approved by the Resident Engineer and Construction Manager. In accordance with the construction specifications, the riprap shall be steel slag as supplied by International Mill Service Corporation, Beaumont, Texas. If sufficient material is not available, the riprap shall comply with the requirements of Common Stone as specified in Item 432 of the TDOT standard specifications. This alternate material may consist of fieldstone, rough unhewn quarry stone, or excavated rock with angular or fractured faces.

Contractor shall perform the following CQC testing of the imported riprap at a frequency of one set of tests for every 10,000 tons delivered to the site:

- bulk specific gravity (ASTM C-127),
- hardness loss by Los Angeles abrasion test (ASTM D4992), and
- sodium sulfate resistance (ASTM D4992).

The Resident Engineer will perform CQA observation of the riprap delivery, on-site handling, and placement activities. Representative samples shall be taken at a

frequency of one per 1,000 tons delivered to the site and tested for sieve analysis (ASTM C-136).

No field density or moisture content testing is required for the riprap material. Placement shall be made in a manner that avoids segregation and damaging the underlying geotextile fabric. Uncontrolled spreading shall not be permitted. CQA testing frequencies for riprap material is summarized in Table 6-1.

6.10 Protective Soil Layer

The protective soil layer, as specified in Section 02200 of the construction specifications, will be placed within the limits of the cap as shown on the construction drawings. The protective soil layer material will be imported to the site. Contractor shall perform the following CQC testing of the imported soil at a frequency of one set of tests for every 2,000 cubic yards delivered to the site from each borrow source, or for each change in material:

- soil classification (ASTM D 2487);
- organic content (ASTM D2974);
- liquid and plastic limit (ASTM D 4318); and
- particle size analysis (ASTM D 422).

Contractor shall also provide evidence to Construction Manager that a representative sample of each soil from each borrow source has been tested using USEPA SW846 test methods for constituents contained in the USEPA target compound list (TCL) and target analyte list (TAL).

The Resident Engineer may obtain samples of the imported material for additional CQA testing at a greater frequency than the Contractor if the Resident Engineer deems it is required. The Resident Engineer will perform CQA testing of placed and compacted soil as deemed warranted. No field density or moisture content tests will be performed on the protective soil layer. Samples of the protective soil layer may be obtained to monitor the moisture content. As specified for general fill, the moisture

- at the start and finish of grading;
- material fails to meet specifications; and
- the work area is reduced.

6.12 Documentation

The documentation of soils CQA testing activities shall be as discussed in Section 5 of this CQA Plan.

content of the protective soil layer shall be within plus or minus three percent of optimum moisture to ensure optimum conditions for maximum compaction. Placement of the protective soil layer shall be made under the continuous observation of the Resident Engineer. CQA testing frequencies for protective soil layer material is summarized in Table 6-1.

6.11 Construction Monitoring

During installation of the various soil components, the Field Technician will visually observe and document the Contractor's earthwork procedures.

The Field Technician will monitor the Contractor's earthwork activities for the following:

- changes in the soil consistency;
- the thickness of lifts as loosely placed and as compacted;
- soil conditioning prior to placement including general observations regarding moisture distribution, clod size, etc.;
- the action of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc.); and
- the number of passes used to compact each lift.

6.11.1 Test Methods

All CQA testing will be conducted in accordance with the project specifications or as directed by the Resident Engineer. The CQA field testing methods used to evaluate the suitability of soils during their installation shall be performed by the Field Technician in accordance with current ASTM or other test procedures indicated in Table 6-1. Test results shall be documented and reported to the Resident Engineer. The Resident Engineer will review the test results and report them to the Construction Manager.

6.11.2 Test Frequency

CQA testing shall be conducted during the course of the work. The minimum testing frequencies are presented in Table 6-1. The frequency may be increased at the discretion of the Resident Engineer and upon the approval of the Construction Manager. Sampling locations shall be selected by the Resident Engineer. If necessary, the location of routine in-place density tests shall be determined using a non-biased sampling approach.

A special testing frequency shall be used at the discretion of the Resident Engineer when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas shall be considered when:

- rollers slip during rolling operation;
- lift thickness is greater than specified;
- soil is at improper and/or variable moisture content;
- it is suspected that less than the specified number of roller passes are made;
- soil-clogged rollers are used to compact the material;
- rollers may not have used optimum ballast;
- soil materials differ substantially from those specified;
- the degree of compaction is doubtful; and
- as directed by the Resident Engineer or Construction Manager.

During construction, the frequency of testing may also be increased in the following situations:

- adverse weather conditions;
- breakdown of equipment;

TABLE 6-1

CQA REQUIREMENTS - EARTHWORK
REVISED REMEDIAL DESIGN
BAILEY SUPERFUND SITE, ORANGE COUNTY, TEXAS

Item	Testing Name	Test Method	Minimum Testing Frequency	Specified Values
1. Subgrade/ Regraded Waste	Proofroll	3 passes of 2-ton roller	All areas beneath cap except dike sideslopes	
2. Waste Relocation		Visual observation		
3. General Fill (off-site borrow source)	TAL and TCL constituents	USEPA SW846	each source	No detects
	Soil Classification	ASTM D 2487	1/2,000 c.y.	SM, ML, CL, CH, SC
	Organic Content	ASTM D 2974	1/2,000 c.y.	<5%
	Moisture-Density Relationship	ASTM D 698	1/2,000 c.y. or change in material	NA
	Particle-Size Analysis	ASTM D 422	Each M-D relationship test	100% <2-inch
	Liquid/Plastic Limit	ASTM D 4318	Each M-D relationship test	LL - 10 to 60 PI - 4 to 40
4. General Fill (field testing)	Field Density (nuclear gauge, sand-cone, or drive cylinder)	ASTM D 2922 D 1556 D 2937	1/10,000 ft^2/lift	95% of max. dry density (ASTM D 698)
	Moisture Content (nuclear gauge, microwave, or oven)	ASTM D 3017 D 4643 D 2216	1/10,000 ft^2/lift	±3% Opt.

TABLE 6-1 (continued)

Item	Testing Name	Test Method	Minimum Testing Frequency	Specified Values
5. Aggregate (on-site source)	Sieve Analysis	ASTM C 136	Request of Resident Engineer based on visual observation	0-15% passing 3/4-inch
6. Aggregate (off-site source)	Sieve Analysis	ASTM C 136	1/1,000 c.y.	100% passing 2-inch 90-100 passing 1½ 20-55 passing 1-inch 0-15 passing 3/4-inch 0-5 passing 3/8-inch
	TAL and TCL Constituents	USEPA SW 846	1 per source	No detects
7. Riprap	Sieve Analysis	ASTM C 136	1/1,000 tons	max. 8-Inch max. 5% passing 3-inch) D_{50} = 4 to 6 inch
	Specific Gravity	ASTM C 127	1/10,000 tons	min. 2.40
	L.A. Abrasion	ASTM D 4992	1/10,000 tons	loss less than 20%
	Sulfate Resistance	ASTM D 4992	1/10,000 tons	loss less than 12%
8. Protective Soil layer (off-site borrow source)	TAL and TCL Constituents	USEPA SW 846	1 per source	no detects
	Soil Classification	ASTM D 2487	1/2,000 c.y.	min. 40% passing #200 sieve
	Organic Content	ASTM D 2974	1/2,000 c.y.	<30%
	Liquid Limit and Plastic Limit	ASTM D 4318	1/2,000 c.y.	LL = 10 to 60 PI = 4 to 35
	Particle Size Analysis	ASTM D 422	1/2,000 c.y.	max. 2 inch

7. GEOSYNTHETIC CLAY LINER QUALITY CONTROL AND ASSURANCE

7.1 Introduction

The Field Technician will monitor the installation of the GCL and the Geosynthetic CQC Laboratory will perform CQC testing on the GCL as required by Section 02276 of the construction specifications and this CQA Plan. The testing used to evaluate the conformance of the GCL with the requirements of the construction specifications will be performed by the Geosynthetic CQC Laboratory in accordance with the current versions of the ASTM or other applicable test procedures indicated in Table 6-1.

7.2 Related Project Specifications

The Contractor shall comply with Section 02276 of the construction specifications. This section shall be referenced for the various physical properties, manufacturing CQC, and installation requirements of the GCL.

7.3 Transportation, Handling, and Storage

The Field Technician will monitor the transportation, handling, and storage of the GCL. Handling of the rolls shall be performed in a competent manner such that damage does not occur to the GCL or its protective wrapping. Any protective wrapping that is damaged or stripped off the rolls shall be repaired immediately to the satisfaction of the Resident Engineer. During transportation, handling, and storage, the GCL rolls will be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

Upon delivery at the site, the Contractor, Geosynthetics Installer, and Field Technician will conduct an inspection of the rolls for defects and damage. This inspection shall be conducted without unrolling the materials unless defects or damages are found or suspected. The Field Technician will indicate to the Resident Engineer:

- rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- rolls which include minor repairable flaws.

The Field Technician will also monitor that equipment used to handle the geosynthetics on-site is adequate and does not pose any risk of damage to the geosynthetics when used properly.

7.4 Conformance Testing

7.4.1 Sampling Procedures

Upon delivery of the rolls of GCL, the Field Technician will ensure that representative GCL conformance samples are obtained at the specified frequency and forwarded to the Geosynthetic CQC Laboratory for testing. GCL conformance samples shall not include the first 3 ft (0.91 m) of material. Unless otherwise specified, conformance samples will be 3 ft (0.91 m) long by the roll width. The Field Technician will tape or otherwise secure the cut edges of the sample to eliminate the loss of the granular bentonite. The required minimum sampling frequencies are provided in Table 7-1. The rolls will be immediately re-wrapped and replaced in their shipping trailers or in the temporary field storage area. The Field Technician will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA personnel identification.

7.4.2 Testing Procedure

Conformance testing of the GCL material delivered to the site will be conducted to ensure compliance with both the construction specifications and the manufacturer's list of minimum average roll values. As a minimum, the GCL conformance test procedures listed in Table 7-1 shall be performed by the Geosynthetic CQC Laboratory.

7.4.3 Test Results

All conformance test results shall be reviewed, accepted, and reported by the Resident Engineer before deployment of the GCL. Any non-conformance of the material's physical properties with the requirements of the project specifications shall be reported to the Construction Manager. In all cases, the test results shall meet, or exceed, the property values listed in Appendix B.

7.4.4 Conformance Test Failure

In the case of failing test results, the Contractor may request that another sample from the failing roll be retested by the Geosynthetic CQC Laboratory with the manufacturer's technical representative present during the test procedure. If the retest fails or if the option to retest is not exercised, then two isolation conformance samples will be obtained by the Field Technician. These isolation samples will be taken from rolls, which have been determined by correlation with the manufacturer's roll number, to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing should continue until passing tests are achieved. All rolls which fall numerically between the passing roll numbers shall be rejected by the Construction Manager. The Field Technician will verify that the Contractor has replaced all rejected rolls. The Field Technician will document all actions taken in conjunction with GCL conformance failures.

7.5 Surface Preparation

The Field Technician and the Geosynthetics Installer will jointly verify that the surface on which the GCL will be installed is acceptable. The Contractor shall comply with the subgrade surface preparation and acceptance requirements identified in Section 02200 of the specifications. The Field Technician will notify the Resident Engineer of any observed change in the supporting soil condition that may require repair work and verify that subgrade repair work is completed in accordance with the requirements of the construction specifications and this CQA Plan.

7.6 Placement

The Field Technician will verify that the Geosynthetics Installer has taken all necessary precautions to protect the underlying subgrade during GCL deployment operations. The Field Technician will verify that all GCL rolls are handled in such a manner as to ensure they are not damaged in any way, and the following conditions are met:

- on slopes, the GCL is secured and then rolled down the slope in such a manner as to continually keep the GCL panel in tension;
- in the presence of wind, the GCL is weighted with sandbags or the equivalent;
- GCL is kept continually under tension to minimize the presence of wrinkles;
- GCL is cut using a utility blade in a manner recommended by the Manufacturer;
- during placement, care is taken not to entrap fugitive clay, sand, stones other debris under the GCL;
- Contractor shall install the overlying geomembrane as soon as possible following GCL installation; Contractor shall cover all GCL that is placed during a work day with overlying geomembrane and Contractor shall also cover and protect the edges of the GCL from hydration due to stormwater run-on;

- GCL that has an internally reinforced sodium montmorillonite core with woven and nonwoven geotextile backings shall be installed with the nonwoven geotextile backing face down;
- installation of GCL on a wet subgrade in standing water, or during precipitation is prohibited;
- personnel are prohibited from walking on dragging equipment across exposed GCL;
- a visual examination of the GCL is carried out over the entire surface, after installation, to ensure that damaged areas, if any, are identified and repaired; and
- if a white colored GCL is used, precautions are taken against "snowblindness" of personnel.

7.7 Overlaps

The Field Technician will monitor and verify the GCL overlapping procedures conform to the requirements of Section 02276 of the specifications. At a minimum, Contractor shall overlap adjacent panels at least 6 in. (152.4 mm) along the sides and 12 in. (304.8 mm) along the ends.

7.8 Repair

The Field Technician will monitor the repair of any holes or tears in the GCL or the geotextile backing. Repairs shall be made by placing a patch made from the same type GCL over the damaged area. On slopes greater than five percent, the patch shall overlap the edges of the hole or tear by a minimum of 2 ft (0.61 m) in all directions. On slopes five percent or flatter, the patch shall overlap the edges of the hole or tear by a minimum of 1 ft (0.30 m) in all directions. The patch shall be secured to the satisfaction

of the Field Technician to avoid shifting during backplacing with soil or covering with another geosynthetic. The patch shall not be nailed or stapled.

TABLE 7-1

GCL CONFORMANCE TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY
GCL Properties		
Hydraulic Conductivity	GRI GCL-2	1 test per lot
Bentonite Content	ASTM D 5261	1 test per 100,000 ft^2
Bentonite Moisture Content	ASTM D 4643	1 test per 100,000 ft^2
Free Swell	ASTM D 5890	1 test per 100,000 ft^2
Thickness	ASTM D 5199	1 test per 100,000 ft^2
Geotextile Properties		
Mass Per Unit Area	ASTM D 5261	1 test per 100,000 ft^2
Grab Strength	ASTM D 4632	1 test per 100,000 ft^2
Tear Strength	ASTM D 4533	1 test per 100,000 ft^2
Puncture Strength	ASTM D 4833	1 test per 100,000 ft^2
Burst Strength	ASTM D 3786	1 test per 100,000 ft^2

8. GEOMEMBRANE CONSTRUCTION QUALITY CONTROL AND ASSURANCE

8.1 Introduction

The Field Technician will monitor the installation of geomembranes and the Geosynthetic CQC Laboratory will perform CQC testing on the geomembrane as required by Section 02277 of the construction specifications and this CQA Plan. The testing used to evaluate the conformance of the geomembrane with the requirements of the construction specifications shall be carried out by the Geosynthetic CQC Laboratory in accordance with the current versions of the ASTM or other applicable test procedures indicated in Tables 8-1 and 8-2.

8.2 Related Project Specifications

The Contractor shall comply with Section 02277 of the construction specifications. This Section shall be referenced for the various physical properties, manufacturing CQC, and installation requirements of the geomembrane materials.

8.3 Transportation, Handling and Storage

The Field Technician will monitor the transportation, handling, and storage of the geomembrane on-site. The Construction Manager shall designate a geomembrane storage location such that on-site transportation and handling are optimized. It will be the responsibility of the Contractor to protect the geomembrane stored on-site from theft, vandalism, and damage.

Upon delivery at the site, the Contractor, Geosynthetics Installer, and Field Technician will conduct an inspection of the rolls for defects and damage. This inspection shall be conducted without unrolling the materials unless defects or damages are found or suspected. The Field Technician will indicate to the Resident Engineer:

- rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- rolls which include minor repairable flaws.

The Field Technician will also monitor that equipment used to handle the geomembrane on-site is adequate and does not pose any risk of damage to the geomembrane when used properly.

8.4 Conformance Testing

8.4.1 Sampling Procedures

Upon delivery of the geomembrane rolls to the site, the Field Technician will ensure that representative geomembrane conformance samples are obtained at the specified frequency and forwarded to the Geosynthetic CQC Laboratory for testing. Geomembrane conformance samples shall be taken across the entire width of the roll and shall not include the first 3 ft (0.91 m) of material. Unless otherwise specified, samples will be 3 ft (0.91 m) long by the roll width. The required minimum geomembrane conformance sampling frequencies are provided in Table 8-1. The Field Technician will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA personnel identification.

8.4.2 Testing Procedures

Conformance testing of the geomembrane materials delivered to the site will be conducted to ensure compliance with both the construction specifications and the manufacturer's list of minimum average roll values. As a minimum, the geomembrane conformance test procedures listed in Table 8-1 will be performed by the Geosynthetic CQC Laboratory to demonstrate that its properties conform to those listed in Table 02277-1 in Appendix C.

8.4.3 Test Results

All conformance test results will be reviewed, accepted, and reported by the Resident Engineer before deployment of the geomembrane. Any non-conformance of the material's physical properties with the requirements of the project specifications will be reported to the Construction Manager. In all cases, the test results will meet, or exceed, the property values listed in Appendix C.

8.4.4 Conformance Test Failure

In the case of failing test results, the Contractor may request that another sample from the failing roll be retested by the Geosynthetic CQC Laboratory with the manufacturer's technical representative present during the test procedure. If the retest fails or if the option to retest is not exercised, then two isolation conformance samples will be obtained by the Field Technician. These isolation samples will be taken from rolls, which have been determined by correlation with the manufacturer's roll number, to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing should continue until passing tests are achieved. All rolls which fall numerically between the passing roll numbers will be rejected by the Construction Manager. The Field Technician will verify that the Contractor has replaced all rejected rolls. The Field Technician will document all actions taken in conjunction with geomembrane conformance failures.

8.5 Subgrade Surface Preparation

The geomembrane will be placed on top of the GCL to provide an essentially impermeable composite barrier. The Field Technician and Geosynthetics Installer will jointly verify that the GCL surface is acceptable for geomembrane installation. The Field Technician will notify the Resident Engineer of any observed change in the supporting GCL that may require repair work and verify that the repair is completed in accordance with the requirements of the construction specifications and this CQA Plan.

8.6 Anchorage Trench

The Field Technician will verify and document that the anchor trench has been constructed according to the construction specifications and drawings. The amount of anchor trench open at any time shall be limited to one day of geomembrane installation capacity. The anchor trench shall be constructed with proper drainage to prevent ponding.

Geosynthetic materials in the anchor trench shall be temporarily anchored with sand bags or other suitable methods approved by the Field Technician or Resident Engineer. The anchor trench shall be backfilled with general fill as indicated in the construction specifications and drawings. In-place moisture/density testing of the compacted anchor trench backfill by nuclear methods will be performed at the discretion of the Resident Engineer.

The anchor trench shall be constructed with a slightly rounded inside corner where the geosynthetics enter the trench. No loose soil shall be allowed to underlie the geosynthetics in the anchor trench. The Field Technician will verify that all temporary ballast (i.e., sandbags) and deleterious materials are removed from the anchor trench prior to backfilling. Backfilling of the anchor trench shall be conducted when the geomembrane is in its most contracted state using extreme care to prevent any damage to the geosynthetic materials.

8.7 Geomembrane Placement

8.7.1 Field Panel Identification

A field panel is the unit area of geomembrane which is to be seamed in the field (i.e., a field panel is a roll or a portion of a roll cut in the field).

The Field Technician will ensure that each field panel is given an "identification code" (number or letter-number) consistent with the layout plan. This identification code will be agreed upon by the Construction Manager, Geosynthetics Installer, and Resident Engineer. The field panel identification code should be as simple and logical as possible. The Geosynthetic Manufacturer's roll numbers shall be traceable to the field panel identification code.

The Field Technician will document the correspondence between roll numbers, factory panels, and field panel identification codes. The field panel identification code will be used for all QA/QC records.

8.7.2 Field Panel Placement

The Field Technician will monitor that field panels are installed at the locations indicated in the Geosynthetic Installer's layout plan, as approved or modified. The Field Technician will record the field panel identification code, manufacturer's roll number, location, date of installation, and dimensions of each field panel.

The Field Technician will monitor geomembrane deployment for the following:

- any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;
- the prepared surface underlying the geomembrane has not deteriorated since previous acceptance and is still acceptable immediately prior to geomembrane placement;

- any geosynthetic elements immediately underlying the geomembrane are clean and free of foreign objects or debris;
- all personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;
- the method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- the method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., by adjacent sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels); and
- direct contact with the geomembrane is kept to a minimum (i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected).

The Field Technician will observe the geomembrane panels after placement and prior to seaming for damage. The Field Technician or Resident Engineer will advise the Construction Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected shall be marked by the Contractor and their removal from the work area recorded by the Field Technician. Repairs shall be made by the Geomembrane Installer according to procedures described in the construction specifications.

8.8 Field Panel Seaming

8.8.1 Panel Layout

The Resident Engineer will review the panel layout drawing provided by the Geomembrane Installer with accepted state of practice and construction specifications the basis for acceptance. A seam numbering system compatible with the field panel identification numbering system will be agreed upon by the Resident Engineer and the Geomembrane Installer prior to any seaming.

8.8.2 Seaming Equipment and Products

Approved processes for field seaming are extrusion welding and fusion welding. Proposed alternate processes shall be documented and submitted to the Construction Manager and approved by the Resident Engineer. Only equipment which have been specifically approved by make and model shall be used. All seaming equipment shall be permanently marked with an identification number.

8.8.3 Seam Preparation

Prior to seaming, the Field Technician will verify that the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material. The seam shall be prepared in accordance with Section 02277 of the construction specifications.

8.8.4 Trial Seams

The Field Technician will verify that the Geosynthetics Installer performs trial seam tests in accordance with Section 02277 of the construction specifications. The Field Technician will observe and document the Geosynthetic Installer's trial seam testing procedures. The trial seam samples will be assigned an identification number and marked accordingly by the Field Technician. Each sample will be marked with the

date, time, machine temperature(s) and setting(s), number of seaming unit, and name of the seaming technician.

8.8.5 Nondestructive Seam Continuity Testing

The Field Technician will verify that the Geosynthetics Installer nondestructively tests all field seams over their full length using a vacuum test unit (for extrusion welds only) or air pressure test (for double fusion seams only). Spark testing may be performed if the seam cannot be tested using the vacuum or air pressure test methods. The purpose of nondestructive tests is to check the continuity of seams. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. The Field Technician will:

- monitor nondestructive testing;
- document the results of the nondestructive testing; and
- inform the Geosynthetics Installer and Resident Engineer of any noncompliance.

Any required seam repairs shall be made in accordance with Section 02277 of the construction specifications. The Field Technician will:

- observe the repair procedures;
- observe the retesting procedures; and
- document the results.

The seam number, date of observation, dimensions and/or descriptive location of the seam length tested, name of person performing the test, and outcome of the test will be recorded by the Field Technician.

8.8.6 Destructive Testing

Destructive seam testing shall be performed during the geomembrane installation in accordance with Section 02277 of the construction specifications. The purpose of this testing is to evaluate seam strength. Destructive seam testing shall be done as the seaming work progresses, not at the completion of all field seaming.

8.8.6.1 Location and Frequency

The Field Technician will select all destructive seam test sample locations. Sample locations will be established as follows:

- a minimum frequency of one test location per 500 ft (152 m) of seam length; this minimum frequency is to be determined as an average taken throughout the entire facility; and
- test locations will be determined during seaming at the Field Technician's discretion; selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The Geosynthetics Installer shall not be informed in advance of the locations where the seam samples will be taken.

8.8.6.2 Sampling Procedures

Destructive seam testing shall be performed as the seaming progresses to obtain the Geosynthetic CQC Laboratory test results before the geomembrane is covered by overlying materials. The Field Technician will:

- observe sample cutting;
- assign a number to each sample, and mark it accordingly; and

- record sample location on layout drawing.

All holes in the geomembrane resulting from destructive seam test sampling shall be immediately repaired and non-destructively tested in accordance with repair procedures described in Section 02277 of the construction specifications.

8.8.6.3 Size of Samples

At a given sampling location, two types of samples (field test samples and laboratory test samples) shall be taken. First, a minimum of two field samples or test strips should be taken for field testing. If both specimens pass the field test described in Section 02277, a second full laboratory destructive sample will be taken for testing by the Geosynthetic CQC Laboratory.

The full destructive sample shall be located between the two field test strips. The sample shall be cut into three parts and distributed as follows:

- one portion to the Geosynthetics Installer;
- one portion to the Construction Manager for archive storage; and
- one portion for Geosynthetic CQC Laboratory testing.

8.8.6.4 Field Testing

The test strips shall be tested in the field, for peel adhesion, using a gauged tensiometer. In addition to meeting the strength requirements outlined in Appendix C, all specimens shall exhibit a Film Tear Bond and shall not fail in the weld. If any field test sample fails to meet these requirements, the destructive sample has failed.

The Field Technician will witness all field tests and mark all samples and portions with their number. The Field Technician will also log the date, number of seaming unit, seaming technician identification, destructive sampling, and pass or fail description.

8.8.6.5 Geosynthetic CQC Laboratory Testing

Destructive test samples will be tested by the Geosynthetic CQC Laboratory. The minimum acceptable values to be obtained in these tests are presented in Appendix C. At least five specimens will be tested for each test method. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, shear). Both the inside and outside tracks of the double track fusion seams will be tested for peel adhesion. A passing test shall meet the minimum required values in at least four out of five specimens.

The Resident Engineer will review laboratory test results as soon as they become available, and make appropriate recommendations to the Construction Manager.

8.8.6.6 Procedures for Destructive Test Failure

The following procedures shall apply whenever a sample fails a destructive test, whether that test was conducted in the field or by the Geosynthetic CQC Laboratory. The Field Technician will monitor that the Geosynthetics Installer follow one of two options:

- Option 1 - The Geosynthetics Installer can reconstruct the seam (e.g., remove the old seam and reseam) between any two passed destructive test locations; or

- Option 2 - The Geosynthetics Installer can trace the welding path to an intermediate location a minimum of 10 ft (3.05 m) from the point of the failed test in each direction and take a small sample for an additional field testing in accordance with the destructive test procedure at each location. If these additional isolation samples pass the field test, then full laboratory samples are taken at both locations. If these laboratory samples meet the specified strength criteria, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

All failed seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 ft (45.72 m) of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing. Repairs shall be made in accordance with this Section. The Field Technician will document all actions taken in conjunction with destructive test failures.

8.9 Defects and Repairs

8.9.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the Field Technician for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean by the Geosynthetics Installer prior to the time of examination. The Field Technician will require the geomembrane surface to be broomed or washed by the Contractor if the amount of dust or mud inhibits examination.

8.9.2 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Geosynthetics Installer in accordance with Section 02277 of the construction specifications. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Contractor and Resident Engineer.

8.9.3 Verification of Repairs

Each repair will be numbered and logged. Each repair shall be non-destructively tested using approved methods. Repairs which pass the non-destructive test shall be taken as an indication of an adequate repair. Large caps may be of sufficient extent to

require destructive test sampling, at the discretion of the Resident Engineer. The Field Technician will observe all non-destructive testing of repairs and will record the number of each repair, date, and test outcome.

TABLE 8-1

GEOMEMBRANE CONFORMANCE TESTING FREQUENCIES

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY
Thickness	ASTM D 751	1 test per 100,000 ft^2
Specific Gravity	ASTM D 792 Method A or ASTM D 1505	1 test per 100,000 ft^2
Tensile Strength at Yield	ASTM D 638	1 test per 100,000 ft^2
Tensile Strength at Break	ASTM D 638	1 test per 100,000 ft^2
Elongation at Yield	ASTM D 638	1 test per 100,000 ft^2
Elongation at Break	ASTM D 638	1 test per 100,000 ft^2
Tear Resistance	ASTM D 1004	1 test per 100,000 ft^2
Carbon Black Content	ASTM D 1603	1 test per 100,000 ft^2
Carbon Dispersion	ASTM D 5596	1 test per 100,000 ft^2

TABLE 8-2

GEOMEMBRANE SEAM TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY
Destructive Seam Testing	ASTM D 4437	1 test per 500 ft of seam length (average)
Shear Strength		
fusion	ASTM D 4437	1 test per 500 ft of seam length (average)
extrusion	ASTM D 4437	
Peel Adhesion		
FTB[1]		1 test per 500 ft of seam length (average)
fusion	ASTM D 4437	
extrusion	ASTM D 4437	
Vacuum Testing	--	100 percent of extrusion welded seams
Air Pressure Testing	--	100 percent of double fusion seams

Note: (1) Film Tear Bond

9. GEOTEXTILE, GEOCOMPOSITE, AND GEOGRID CONSTRUCTION QUALITY CONTROL AND ASSURANCE

9.1 Introduction

The Geosynthetic CQC Laboratory will perform conformance testing on the geotextiles, geocomposite, and geogrid. The Field Technician will monitor the installation of geotextiles, geocomposites, and geogrids. These activities will be performed in accordance with Sections 02278, 02279, and 02280 of the construction specifications and this CQA Plan. The testing used to evaluate the conformance of the geotextiles, geocomposites, and geogrids with the requirements of the construction specifications shall be performed by the Geosynthetic CQC Laboratory in accordance with the current versions of the ASTM or other applicable test procedure indicated in Table 9-1.

9.2 Related Project Specifications

The Contractor shall comply with Sections 02278, 02279, and 02280 of the construction specifications. These Sections shall be referenced for specific details of the geotextile, geocomposite, and geogrid material properties, manufacturing CQC, and installation requirements.

9.3 Geotextiles

Geotextile cushion and separator to be placed beneath riprap and the final access road shall be 16 oz (450 g) needlepunched nonwoven material currently available on-site as discussed in Section 02278 of the construction specifications. Geotextile filter material used in the sumps at the gas collection system vents and in the consolidation water collection trenches and sumps shall be of the same material.

9.3.1 Transportation, Handling and Storage

The Field Technician will monitor the transportation, handling, and storage of the geotextiles on-site. The Construction Manager shall designate a geotextile storage location such that on-site transportation and handling are optimized. During transportation, handling, and storage, the Contractor shall protect the geotextile from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

Handling of the geotextile rolls shall be performed in a competent manner such that damage does not occur to the geotextile nor to its protective wrapping. Rolls of geotextile shall not be stacked upon one another to the extent that deformation of the core occurs or to the point where accessibility can cause damage in handling. Protective wrappings shall be removed less than one hour prior to unrolling the geotextile. After unrolling, a geotextile shall not be exposed to ultraviolet light for more than 10 calendar days, unless otherwise specified by the Construction Manager.

The Contractor, Geosynthetics Installer, and Field Technician will conduct an inspection of the rolls for defects and damage. This inspection shall be conducted without unrolling the materials unless defects or damages are found or suspected. The Field Technician will indicate to the Resident Engineer:

- rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- rolls which include minor repairable flaws.

The Field Technician will also monitor that equipment used to handle the geotextiles on-site is adequate and does not pose any risk of damage to the geotextiles when used properly.

9.3.2 Conformance Testing

Conformance testing of the 16 oz (450g) needlepunched nonwoven material currently available on-site will not be required. Manufacturer's data on this material is not available. The location of placement of the geotextile is considered to be a non-critical application. However, if additional material is required from an off-site source, manufacturer's QA test reports shall be submitted to the Resident Engineer for each roll delivered to the site. Additional CQC testing will be at the discretion of the Resident Engineer.

9.3.3 Placement

The Field Technician will monitor the placement of all geotextiles to ensure they are not damaged in any way, and that they are placed in accordance with Section 02278 of the construction specifications.

9.3.4 Seams and Overlaps

The geotextiles will be continuously overlapped as specified in Section 02278 of the construction specifications. At a minimum, Contractor shall continuously overlap a minimum of 6 in. (152.4 mm) and sew filter and cushion geotextiles using a "single prayer" seam.

9.3.5 Repair

The Field Technician will verify that any holes or tears in the geotextile are repaired. The geotextile patches shall be made of the same geotextile, cut and placed as specified in Section 02278 of the construction specifications. The Field Technician will observe all repairs and ensure that any non-compliance with the construction specifications is corrected.

9.3.6 Placement of Soil Materials

The Field Technician will monitor the Contractor's placement of all earthwork materials (soil, aggregate, and riprap) located on top of a geotextile in accordance with Section 02278 of the construction specifications, to verify:

- that no damage occurs to the geotextile;
- that no shifting of the geotextile from its intended position occurs and underlying materials are not exposed or damaged; and
- that excess tensile stress does not occur in the geotextile.

Contractor shall not drive directly on the geotextile and shall only use equipment that meets the ground pressure requirements of Section 02278 of the construction specifications.

9.4 Geocomposites

Both one-sided and two-sided geocomposites will be used in the construction of the RRD. One-sided geocomposites, with the geonet component facing down, will be placed over the geomembrane component of the final cap. Two-sided geocomposite shall be installed for the gas venting layer and any other locations where the geocomposite will be placed on the soil. Both types of geocomposite supplied shall have properties that conform to the requirements specified in Appendix D and shall be sampled and tested as directed in the construction specifications Section 02279 and at the frequencies listed in Table 9-1 of this CQA Plan.

9.4.1 Transportation, Handling and Storage

The geocomposite manufacturer shall supply geocomposites in rolls wrapped in relatively impermeable, opaque coverings to the site at least 14 calendar days prior to planned deployment to allow the Resident Engineer adequate time to perform

conformance testing. The rolls will be marked according to ASTM D 4873 with the following information:

- manufacturer's name;
- product identification;
- lot or batch number;
- roll number; and
- roll dimensions.

The Field Technician will monitor the transportation, handling, and storage of the geocomposites on-site. The Construction Manger shall designate a geocomposite storage location such that on-site transportation and handling are optimized. During transportation, handling, and storage, the Contractor shall protect the geocomposite from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

Handling of the geocomposite rolls shall be performed in a competent manner such that damage does not occur to the geocomposite nor to its protective wrapping. Rolls of geocomposite shall not be stacked upon one another to the extent that deformation of the core occurs or to the point where accessibility can cause damage in handling. Furthermore, geocomposite rolls shall be stacked in such a way that access for conformance sampling is possible. Protective wrappings shall be removed less than one hour prior to unrolling the geotextile. After unrolling, a geocomposite shall not be exposed to ultraviolet light for more than 14 calendar days, unless otherwise specified by the Construction Manager.

Upon delivery at the site, the Contractor, Geosynthetics Installer, and Field Technician shall conduct an inspection of the rolls for defects and damage. This inspection shall be conducted without unrolling the materials unless defects or damages are found or suspected. The Field Technician will indicate to the Resident Engineer:

- rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- rolls which include minor repairable flaws.

The Field Technician will also verify that equipment used to handle the geocomposites on-site is adequate and does not pose any risk of damage to the geocomposites when used properly.

9.4.2 Conformance Testing

9.4.2.1 Sampling Procedures

Samples will be taken across the entire width of the roll and shall not include the first 3 ft (0.91 m). Unless otherwise specified, samples shall be 3 ft (0.91 m) long by the roll width. The required minimum geocomposite conformance sampling frequencies are provided in Table 9-1. The Field Technician will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQC personnel identification.

The geocomposite rolls which are sampled shall be immediately rewrapped in their protective coverings to the satisfaction of the Field Technician or Resident Engineer.

9.4.2.2 Testing Procedure

Conformance testing of the geocomposite materials delivered to the site will be conducted to ensure compliance with both the construction specifications and the manufacturer's list of minimum average roll values. As a minimum, the geocomposite conformance test procedures listed in Table 9-1 shall be performed by the Geosynthetic CQC Laboratory to demonstrate that its properties conform to those listed in Table 02279-1 in Appendix D.

9.4.2.3 Test Results

All conformance test results will be reviewed, accepted, and reported by the Resident Engineer before deployment of the geocomposite. Any non-conformance of the material's physical properties with the requirements of the project specifications shall be reported to the Construction Manager. In all cases, the test results shall meet, or exceed, the property values listed in Appendix D.

9.4.2.4 Conformance Test Failure

In the case of failing test results, the Contractor may request that another sample from the failing roll be retested by the Geosynthetic CQC Laboratory with the manufacturer's technical representative present during the test procedure. If the retest fails or if the option to retest is not exercised, then two isolation conformance samples will be obtained by the Field Technician. These isolation samples will be taken from rolls, which have been determined by correlation with the manufacturer's roll number, to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing should continue until passing tests are achieved. All rolls which fall numerically between the passing roll numbers shall be rejected by the Construction Manager. The Field Technician will verify that the Contractor has replaced all rejected rolls. The Field Technician will document all actions taken in conjunction with geocomposite conformance failures.

9.4.3 Placement

The Field Technician will monitor the placement of all geocomposites to ensure they are not damaged in any way and that they are placed according to Section 02279 of the construction specifications.

9.4.4 Seams and Overlaps

The geotextile and geonet components of the geocomposite will be secured or seamed to the like component at overlaps according to Section 02279 of the construction specifications.

9.4.5 Repair

The Field Technician will verify that any holes or tears in the geocomposite are repaired. The geocomposite patch shall be cut and placed as specified in Section 02279 of the Construction Specifications. The Field Technician will observe all repairs and ensure that any non-compliance with the construction specifications is corrected.

9.4.6 Placement of Soil Materials

The Field Technician will monitor the Contractor's placement of all soil materials on top of geocomposite in accordance with Section 02279 of the construction specifications, to verify:

- that no damage occurs to the geotextile;
- that no shifting of the geotextile from its intended position occurs and underlying materials are not exposed or damaged; and
- that excess tensile stress does not occur in the geotextile.

Contractor shall only use equipment that meets the ground pressure requirements specified in Section 02279 of the construction specifications in areas where a geocomposite or geomembrane has been installed.

9.5 Geogrids

9.5.1 Introduction

Geogrid material will be installed during the construction of the final access road on the cap. The material will be a Tensar BX1200 biaxial geogrid, manufactured by The Tensar Corporation. An alternate material may be used if the short-term tensile modules yield strength and junction strength is at least 80 percent of the values for BX1200 geogrid. Aperture dimensions for an alternative product shall be within +/- 20 percent of the aperture dimensions of the BX1200 geogrid. Manufacturer's QC test reports shall be submitted to the Resident Engineer for each roll delivered to the site. The need to perform CQA testing of the geogrid material will be at the discretion of the Resident Engineer. The need for additional testing will be based on the visual appearance of the material and if any defects are observed in the material. The testing specifications for the geogrid material will be based on the latest version of the average minimum roll values for the BX1200 material published by the manufacturer.

Geogrid material for use in soft-spot stabilization shall be Tensar UX1700 uniaxial geogrid that is currently available on-site. No conformance testing will be required for use of this material. However, if additional material is required from an off-site source, manufacturer's QC test reports shall be submitted to the Resident Engineer for each roll delivered to the site. Additional CQA testing will be at the discretion of the Resident Engineer. The testing specifications for the geogrid material will be based on the latest version of the average minimum roll values for the UX1700 material published by the manufacturer.

9.5.2 Related Project Specifications

The Contractor shall comply with Section 02280 of the construction specifications and the construction drawings for the product requirements and placement.

TABLE 9-1

GEOCOMPOSITE CONFORMANCE TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM TESTING FREQUENCY
Geonet Component:		
Resin Density[1]	ASTM D 1505	100,000 ft^2
Carbon Black Content	ASTM D 1063	100,000 ft^2
Thickness	ASTM D 5199	100,000 ft^2
Weight per Square Foot	ASTM D 2776 (option C)	100,000 ft^2
Geotextile Component:		
Mass per Unit Area	ASTM D 5261	100,000 ft^2
Geotextile Filter Requirements		
Apparent Opening Size	ASTM D 4751	1 per lot
Hydraulic Conductivity	ASTM D 4491	1 per lot
Mechanical Requirements		
Grab Strength	ASTM D 4632[2]	1 per 100,000 ft^2
Tear Strength	ASTM D 4533	1 per 100,000 ft^2
Puncture Strength	ASTM D 4833	1 per 100,000 ft^2
Burst Strength	ASTM D 3786	1 per 100,000 ft^2
Geocomposite Drainage Layer:		
Transmissivity (one-sided)	ASTM D 4716[3]	1 per lot
Transmissivity (two-sided)	ASTM D 4716[3]	1 per lot
Peel Strength	ASTM D 904	1 per 100,000 ft^2

Notes:
1. The density of the net resin shall not exceed that of the underlying geomembrane.
2. Minimum values measured in machine and cross machine directions with 1 in. (25.4 mm) clamp on Constant Rate of Extension (CRE) machine.
3. Transmissivity shall be measured using water at 68°F (20°C) ± 5°F (3°C) with a hydraulic gradient of not more than 0.1 under a confining pressure of 150 to 250 pounds per square foot (lb/sf). The geocomposite shall be placed in a testing device between a smooth geomembrane liner and an overlying soil bedding layer. Measurements shall be taken one hour after application of confining pressure.

10. GAS VENTING SYSTEM

10.1 Components

The Field Technician will verify that the materials used in the construction of the gas venting system conform to the construction drawings and Section 02717 of the construction specifications. The Field Technician will verify that the geotextile, geocomposite, and aggregate used in construction of the gas venting system is placed and conformance tested in accordance with the construction specifications and this CQA Plan.

10.2 Conformance Testing

The Contractor shall submit manufacturer's information and QC reports for all materials used in the construction of the gas venting system as required in Section 02717 of the construction specifications. Conformance testing of the materials will not be required unless the Resident Engineer believes that the material supplied to the site may not meet the performance requirements or material requirements of the project. The type of testing and frequency will be at the sole discretion of the Resident Engineer.

The Field Technician will visually review the materials delivered to the site for conformance with the project specifications. Observations and measurements may include:

- diameter of pipe;
- wall thickness of pipe;
- length of pipe; and
- location and diameter of perforations.

10.3 Installation

The Field Technician will monitor the installation of all elements of the gas vents and gas collection system, including placement of geotextile, aggregate, vent pipe, geomembrane boot, penetration details, and other miscellaneous items as specified in Section 02717 of the construction specifications and as shown on the construction drawings. The Contractor and Field Technician will examine the pipes and fittings before installation to ensure defective components are not incorporated and the inside of the pipes and fittings are free of dirt and debris. The Field Technician will verify that the Contractor has installed the following items:

- wire screen at the open ends of the riser pipe;
- all joints in the riser pipe are intact;
- gravel backfill has been placed to the depth indicated on the construction drawings;
- no damage has occurred to the liner system during installation of the gas vents;
- gas riser penetrations through the geomembrane are sealed with an approved sealing method as shown on the construction drawings; and
- the pre-cast concrete manhole sections are installed level and backfilled with gas vent aggregate.

10.4 Repair

The Field Technician will monitor any repairs to the gas vents or gas collection system and ensure that any non-compliance with the construction documents is corrected.

11. EROSION CONTROL CONSTRUCTION QUALITY ASSURANCE

11.1 Introduction

The Field Technician will monitor the installation and construction of all erosion control measures including erosion and sediment control, site clearing and grubbing, and revegetation as required by Sections 02290, 02110 and 02930, respectively, of the construction specifications and this CQA Plan.

11.2 Related Project Specifications

The Contractor shall comply with Sections 02290, 02110, and 02930 of the construction specifications. These specifications shall be referenced for specific details regarding the requirements for all erosion control construction and installation.

11.3 Erosion and Sediment Control

The Field Technician will verify that the Contractor is using the appropriate type of silt fencing for the construction area and that all fencing is being placed according to the construction drawings and Section 02290 of the construction specifications. Silt fencing shall be provided at locations shown on the Constructions Drawings, locations where surface water leaves the work area, other locations of ground disturbance, and other locations identified by the Resident Engineer or Construction Manager.

11.3.1 Silt Fencing in Areas Subject to Inundation

11.3.1.1 Components

The silt fence fabric may be either woven or nonwoven fabric as specified in Section 02290 of the construction specifications.

The silt fence fabric shall conform to the tests and specifications as outlined in Table 11-1.

The Field Technician will verify that the fence posts are a minimum of 5 ft (1.52 m) in length and of sound quality hardwood with a nominal cross sectional area of 2 x 2 in. (50.8 m). Wire fencing shall be a minimum of 14-1/4-gage welded wire fabric with a maximum of 6-in. (152.4 mm) mesh openings, or as approved by the Construction Manager.

11.3.1.2 Installation

The Field Technician will verify the Contractor installed the silt fencing properly as specified in Section 02290 of the construction specifications. The Field Technician will verify that the fence posts are installed a maximum of 4 ft (1.22 m) apart and the toe of the silt fence shall be buried a minimum of 6 in. (152.4 mm) below the ground surface.

11.3.2 Silt Fencing in Areas Not Subject to Inundation

The Field Technician will verify that all materials and methods conform to the requirements found in the TDOT, Design Division (Roadway), Standard Sheets and Design Details, Sheet EC(l)-93.

11.3.3 Silt Fencing Within Removal Areas

The Contractor shall provide other Resident Engineering controls as necessary to prevent waste migration into clean areas during waste removal activities.

11.3.4 Erosion Control During Construction

The Field Technician will verify that sufficient precautions have been taken during construction to limit the run-off of polluting substances such as silt, clay, wastes, fuels,

and oils from the work area. Contractor shall take special precautions in the use of construction equipment to prevent operations which promote erosion. The Field Technician will verify that the Contractor removes accumulated silt and debris deposits when they reach approximately one half the height of the fence. Silt fence fabric shall be replaced if damaged during construction.

11.3.5 Erosion Control Following Completion of Cap

The Field Technician will verify that the Contractor has installed TDOT pre-fabricated silt-fence along the perimeter of all revegetated areas. The Field Technician will verify that the contractor is removing accumulated silt from behind the fences until an adequate stand of grass is established. The silt fence shall be disposed off-site when an adequate stand of grass has been established according to the Construction Manager.

11.4 Site Clearing and Grubbing

The Field Technician will verify that all erosion and sediment controls have been installed in the relevant areas shown on the construction drawings prior to any clearing and grubbing. The Field Technician will monitor the Contractor to ensure clearing and grubbing operations are performed in a manner that limits disturbance of Pond A, the North Marsh Area, the drainage channel, and the surrounding areas in accordance with the construction drawings and Section 02110 of the construction specifications.

11.5 Revegetation

11.5.1 Components

The Field Technician will verify the materials used for revegetation to conform to the following requirements.

- fertilizer materials and application methods shall meet the requirements of TDOT Standard Specifications, Item 166;
- seed mixes and application methods shall meet the requirements of the TDOT Standard Specifications Item 164; areas not suitable to seed shall be straw mulched at a rate of two tons per acre until seeding can be facilitated; changes to the seed mix shall be approved by the Construction Manager;
- agricultural lime material and application methods shall meet those provided by the local Soil Conservation Service office;
- mulch material and application methods shall meet those given in the TDOT Standard Specifications, Item 164; and
- contractor shall use clean, potable water.

11.5.2 Installation

The Field Technician will verify that the installation of the revegetation is done according to Section 02930 of the construction specifications. The Field Technician will verify that all washouts are regraded and reseeded.

TABLE 11-1

SILT FENCE FABRIC TESTING CRITERIA

TEST NAME	TEST METHOD	UNITS	SPECIFICATION LIMITS
Grab Tensile Strength	ASTM D 4632	lbs (min)	90
Tensile Elongation	ASTM D 4632	% (min)	15
Tensile Elongation	ASTM D 4632	% (max)	115
Burst Strength	ASTM D 3786	psi (min)	175
Puncture Strength	ASTM D 4833	lbs (min)	60
Flow Rate	ASTM D 4491	gpm/sq ft (min)	25
Apparent Opening Size (U.S. Standard Sieve)	ASTM D 4751	-	30 - 100
Ultraviolet Radiation Stability	ASTM D 4355	%	80

12. WASTEWATER TREATMENT QUALITY ASSURANCE

12.1 Introduction

The Field Technician will monitor the construction of the wastewater management system and consolidation water collection system as required by Sections 02675 and 13070 of the construction specifications and this CQA Plan. The Construction Manager will monitor the operation of the wastewater treatment plant, sample analysis and review the data packages submitted by the Contractor.

12.2 Related Project Sections

The Contractor shall comply with Sections 02675 and 13070 of the construction specifications. These specifications shall be referenced for specific details regarding the requirements for all general construction activities and operations concerning Wastewater Treatment Quality Assurance.

12.3 Wastewater Management System

12.3.1 Components

The Field Technician will verify that the materials used in the construction of the wastewater management system complies with Section 02675 of the construction specifications. The wastewater management system components include, but are not limited to the following:

- collection and conveyance system including all pipes, pumps, valves, controls, tanks, treatment units, disposable items, and filters;
- equalization tank;
- automatic sampling device connected to the discharge line; and

- existing wastewater treatment system.

The Contractor may use the existing wastewater treatment system subject to the following conditions:

- Contractor shall evaluate the existing system to ensure that it is adequate for the purpose intended;
- Contractor shall notify the Construction Manager of any defects or damage to the existing system;
- existing system shall be returned to its original condition if modifications are to be made;
- all carbon absorbers or filters shall be regenerated or replaced at the completion of the work; and
- any items damaged by the Contractor shall be repaired or replaced.

12.3.2 CQC Testing

The Contractor shall verify that the designed wastewater treatment system is capable of handling brackish water without fouling of the system. The Contractor shall sample the treated wastewater and submit the samples to the Wastewater CQC Laboratory for analysis. The Contractor shall verify that the treated wastewater has constituents less than the limits specified in Table 12-1. The Contractor shall also verify that the air emissions from any treatment system component shall be controlled such that the action levels for the site are not exceeded as outlined in the Revised Air Monitoring Plan for Final Remediation.

12.3.3 System Start-Up

The Field Technician shall monitor the wastewater treatment system shakedown and verify system performance as specified in Section 02675 of the construction

specifications. Constituents in treated wastewater shall meet the criteria listed in Table 12-1 and the frequency of wastewater and CQC sample collection is summarized in Tables 12-2 and 12-3, respectively.

12.3.4 System Operation

During the wastewater treatment system operation, the Construction Manager shall verify that the treated wastewater is sampled by the Contractor at least once per week or once per discharge. The samples shall be analyzed by the Wastewater CQC Laboratory for constituents listed in the Table 12-1. Analytical results shall be submitted to the Construction Manager within three working days of sample collection, together with a certificate that treatment standards have been attained. If the sample does not meet treatment standards, the Contractor shall immediately implement a contingency plan that includes the following as a minimum:

- immediately cease discharge and recirculate 100 percent of flow back to the equalization tank;
- investigate the problem and take corrective action; and
- following corrective action, implement system start-up procedures as described in Section 02675 of the construction specifications.

The Contractor shall submit complete CQC packages, as specified in the QAPP, to the Construction Manager within 21 calendar days of sample collection. The Contractor shall validate the data and summarize the results in a manner that is reportable to EPA (i.e., providing a summary table of results which includes sample results compared to criteria, a recommendation to discharge or not discharge water, sample dates and numbers, description of source of water treated, and what type of sample was collected, etc.). The Construction Manager shall verify that the wastewater management system is operated by suitably qualified personnel.

12.4 Consolidation Water Collection System

12.4.1 Components

The Field Technician will verify that the components used are in accordance with the construction drawings and Section 13070 of construction specifications.

12.4.2 CQC Assurance

Upon delivery of the consolidation water collection system components to the site, the Field Technician will inspect the materials to determine if any are damaged or defective. Damaged or defective materials will be rejected and replaced with new materials. Pipes will be checked to verify that they have been marked with the manufacturer's identification symbol, size, date of manufacture, and other applicable product information.

The Field Technician will verify the earthwork construction for the trenches is performed in accordance with Section 02200 of the construction specifications and drawings. In particular, the Field Technician will check that placement of the backfill is done in a manner as to not damage the pipes or geotextile. The Field Technician will also observe that at the completion of the placement of the backfill, the geotextile fabric is overlapped across the entire width of the trench and that sufficient general fill is placed to hold the geotextile in place.

12.4.3 Installation

12.4.3.1 Geotextile

The Field Technician will verify that the geotextile is installed in accordance with Section 02278 of the construction specifications and the following:

- verify the surface to receive the geotextile is free of litter and sharp protrusions;

- the geotextile is placed in the bottom and the sides of the pipe trench as shown in the construction drawings; and
- confirm that the overlaps of adjacent rolls of geotextile at the top of the aggregate backfill shall be approximately 2 ft (0.61 m).

12.4.3.2 Pipe

The Field Technician will examine all pipes and fittings before installation to ensure that defective materials are not incorporated and that the insides of the pipes and fittings are free of dirt and debris. The Field Technician will verify that each joint is set to line and grade as indicated on the construction drawings and Section 13070 of the construction specifications. Whenever pipe laying is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent soil and other foreign matter from entering the piping. After each joint is made, the Field Technician will check that enough back fill material is placed along the pipe to prevent movement off line or grade; however, the pipe shall not be covered until pipe installation has been approved by the Field Technician or Resident Engineer.

12.4.3.3 Sump Installation

The Field Technician will verify that the Contractor installs the corrugated metal pipe as shown in the construction drawings.

12.4.4 System Operation

The Field Technician will verify that the Contractor operates the consolidation water collection system during and for 14 calendar days after the placement of the general fill. The water levels in the sumps shall be maintained by the Contractor at or below the PVC pipe invert elevation by pumping the collected water to the on-site wastewater treatment system using temporary pumps and pipes. Removal of the liquid

shall be in accordance with Section 02140 of the construction specifications and treated in accordance with Section 02675 of the construction specifications.

TABLE 12-1

WASTEWATER DISCHARGE CRITERIA

POLLUTANT	COMPOSITE SAMPLE (mg/1)	GRAB SAMPLE (mg/1)
Arsenic	0.2	0.4
Cadmium	0.1	0.2
Chromium	0.2	0.4
Lead	0.5	1.0
Mercury	0.01	0.02
Selenium	0.2	0.4
Silver	0.1	0.2
Pentachlorophenol	1.23	2.60
Phenanthrene	0.62	1.32
Oil and Grease	-	15
TDS	13,000	15,000
VOC	<1.0	<1.0
TOC	15	30
pH	6 - 9	6 - 9

NOTE: A 24-hour acute whole effluent toxicity test shall be conducted every week during which discharge occurs. The criteria for discharge is a greater than 50 percent survival in 100 percent effluent concentration. Methods for analysis are provided in the Quality Assurance Project Plan (QAPP).

TABLE 12-2

FREQUENCY OF SAMPLE COLLECTION FROM THE WASTEWATER TREATMENT PLANT BAILEY SUPERFUND SITE

SCENARIO	WWTP	SAMPLE FREQUENCY AND TYPE[1]
Startup	New Plant	3 grab samples per day within an 8-hr period. Repeat until results show criteria have been met.
Prior to Discharge from Holding Tanks	New and Existing	One grab sample.
Continuous Discharge	New and Existing	1 grab sample per week.[2] 1 composite sample per week.[2]

NOTE: (1) This information takes precedent over information presented in the Quality Assurance Project Plan if a conflict between the two occurs.

(2) If system operates for less than one week, at least one set of samples shall be taken during the operating period.

TABLE 12-3

COLLECTION FREQUENCY OF CQC SAMPLES FOR SAMPLES COLLECTED FROM THE WASTEWATER TREATMENT PLANTS BAILEY SUPERFUND SITE

BLANKS		FIELD DUPLICATE	MS/MSD
FIELD RINSATE	**TRIP**		
1 Field blank per day	1 per day in each shipping container	**During plant startup:** 1 per day	**During plant startup:** 1 per day
		From holding tanks prior to discharge: 1 grab duplicate per day	**For a New Plant: From holding tanks prior to discharge:** 1 per day
Note: Field blanks are not required if sample collected directly from WWTP pipe per EPA's letter dated 2/5/96.		**During continuous discharge:** grab samples - 1 per day composite samples - 1 per day	**During continuous discharge:** 1 per sampling event. A sampling event is defined as those samples collected from one WWTP over a continuous discharge period.

NOTE: This information takes precedent over information presented in the Quality Assurance Project Plan if a conflict between the two occurs.

13. AIR MONITORING QUALITY ASSURANCE

13.1 Air Monitoring

The Contractor shall be responsible for performing air monitoring during the remedial activities at the site. All air monitoring shall comply with the Revised Air Monitoring Plan for Final Remediation (August 1996). Contractor shall be responsible for submitting field logs for air monitoring performed to the Construction Manager on a daily basis. These logs will include all recordkeeping information required in Section 7 of the Revised Air Monitoring Plan for Final Remediation. Documentation sampling described in Sections 3.4 and 3.5 of the Revised Air Monitoring Plan for Final Remediation will be performed by the Construction Manager and is not the responsibility of the Contractor. The air monitoring plan shall be followed whenever any work involves disturbing waste material, or disturbing material that has come into contact with waste material. Work activities in this category include, but are not limited to the following:

- installation of the consolidation water collection trench;
- waste removal and/or relocation; and
- site grading in waste material.

13.2 Air Monitoring for Worker Health and Safety Exposure

Air monitoring for worker health and safety exposure is different from the air monitoring described in Section 13.1 of this CQA Plan and shall be performed separately. This air monitoring shall satisfy the minimum requirements of the Site Air Monitoring Plan, described in Section 01620 of the construction specifications.

APPENDIX A

EXAMPLES OF CQA FORMS

GeoSyntec Consultants

FIELD FORMS – ORDER SHEET
(SUBMIT TO GEORGIA FIELD SERVICES ADMINISTRATOR)

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

DATE ORDERED: ____
DATE NEEDED: ____

NO. OF COPIES	FORM NO.	GENERAL FORM TITLE
	1-01-FSF	Field Order Forms-Order Sheet (Front Side)
	1-16-FSF	Field Order Forms-Order Sheet (Back Side)
	1-02-SPS	Senior Personnel Summary Log
	1-03-PDL	Personnel Daily Log
	1-04-DFR	Daily Field Report
	1-05-WFR	Weekly Field Report
	1-06-DWL	Daily Weather Log
	1-07-TLF	Transmittal Letter
	1-08-FCO	Field Change Order
	1-09-FRF	Field Release Form
	1-10-HTL	Pressure Test Log
	1-11-CST	Compressive Strength Test of Concrete Specimens
	1-12-SDL	Survey Data Log
	1-13-SCS	Submittal Cover Sheet
	1-14-SLF	Submittal Log Form
	1-15-PLF	Photographic Log Form
	1-17-MSS	Meeting Sign In Sheet
	1-18-CMR	Field Report-Construction Manager
	1-19-SSF	Site Safety Form
	1-20-DTF	Design Transmittal
	1-21-ESR	Field Report-Erosion and Sediment
	1-22-DCO	Design Change Order
	1-23-CRF	Clarification Request Form

NO. OF COPIES	FORM NO.	SOILS FORM TITLE
	2-01-SSL	Soil Sample Log
	2-02-FSD	Field (Speedy) Determination of Moisture Content of Soil
	2-03-LDM	Lab Determination of Moisture Content of Soil
	2-04-FLC	Field Laboratory Compaction Test ASTM D 698 Method A
	2-05-FLC	Field Laboratory Compaction Test ASTM D 698 Method B
	2-06-FLC	Field Laboratory Compaction Test ASTM D 698 Method C
	2-08-FLC	Field Laboratory Compaction Test ASTM D 1557 Method A
	2-09-FLC	Field Laboratory Compaction Test ASTM D 1557 Method B
	2-10-FLC	Field Laboratory Compaction Test ASTM D 1557 Method C
	2-12-MDR	Moisture Density Relationships
	2-13-ALT	Atterberg Limits Test (ASTM D 4318)
	2-14-PMS	Particle Size Analysis, Mechanical Sieve Method (ASTM D 422)
	2-15-PHM	Particle Size Analysis, Hydrometer Method (ASTM D 422)
	2-16-PSD	Particle Size Distribution and Soil Classification Test Results
	2-17-FCB	Field Calibration of Bulk Density of Sand for Sand Cone
	2-18-FSC	Field Sand Cone Density Test (ASTM D 1556)
	2-19-NGS	Nuclear Gauge Standard Count Log (ASTM D 2922) (ASTM D 3019)
	2-20-FNM	Field Nuclear Moisture/Density Test Log
	2-21-SFD	Summary of Field Density Test
	2-22-LTS	Laboratory Test Summary
	2-23-LTR	Laboratory Test Request

NO. OF COPIES	FORM NO.	GEOSYNTHETICS FORM TITLE
	3-01-MIF	Material Inventory
	3-02-CAS	Certificate of Acceptance Subgrade Surface
	3-03-PPA	Panel Placement Log (Without Temperature)
	3-12-PPB	Panel Placement Log
	3-04-TEA	Trial Seam Log-(Extrusion) (Without Temp.)
	3-13-TEB	Trial Seam Log-(Extrusion) (With Temp.)
	3-05-TFA	Trial Seam Log-(Fusion) (Without Temp.)
	3-14-TFB	Trial Seam Log-(Fusion)
	3-06-PSA	Production Seam Log (Without Temperature)
	3-15-PSB	Production Seam Log
	3-07-SPR	Seam and Panel Repair Location Log
	3-16-SPR	Seam and Panel Repair Location Log (Std.)
	3-08-SYM	Symbols (Back of Seam Log)
	3-09-RSL	Repair Summary Log
	3-10-DTL	Destructive Test Log
	3-11-NTL	Nondestructive Test Log

NO. OF COPIES	FORM NO.	SUPPLEMENTARY FORM TITLE	NO. OF COPIES	FORM NO.	VOID FORM TITLE	NO. OF COPIES	FORM NO.	
	4-01-CRS	Cost Recovery Sheet		1-02-CPS	Contractor Personnel Summary Log			
	4-02-SGP	Summary of Geosynthetic Production		2-07-FLC	Field Laboratory Compaction Test ASTM D 698 Method D			
	4-03-GCF	Gasket Composite Form		2-11-FLC	Field Laboratory Compaction Test ASTM D 1557 Method D			
	4-04-DTF	Destructive Test Frequency		2-12-MDR	Moisture-Density Relationship			
	4-05-APT	Air Pressure Test Log						
	4-06-VTL	Vacuum Test Log						
	4-07-DTL	Field Destructive Test Log						
	4-08-LTR	Laboratory Test Request						

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

PERSONNEL DAILY LOG

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

NAME	REF ID	COMPANY	MON	TUES	WED	THURS	FRI	SAT	SUN

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

DAILY FIELD REPORT

PROJECT: BAILEY SUPERFUND SITE

LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610

DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

CONTRACTOR: ____

WEATHER: ____

COPY TO: ____ PER: ____ HRS: ____

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

FIELD REPORT-EROSION & SEDIMENTATION

PROJECT: BAILEY SUPERFUND SITE

LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610

DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

WEATHER: ____

AREA:

CONTRACTOR:

EQUIPMENT USED:

WORK PERFORMED:

AREA:

CONTRACTOR:

EQUIPMENT USED:

WORK PERFORMED:

AREA:

CONTRACTOR:

EQUIPMENT USED:

WORK PERFORMED:

COPY TO: ____ PER: ____

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

CLARIFICATION REQUEST

PROJECT: BAILEY SUPERFUND SITE

LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610

DESCRIPTION: REVISED FINAL REMEDIATION DATE: _____ day _____ month 1996 year

OWNER: _____

TO: .....

FROM: .....

DATE: .....

CLARIFICATION REQUESTED: .....

REQUESTED BY: _____ DATE: _____
(SIGNATURE AND TITLE) (day/month/year)

RESPONSE TO CLARIFICATION REQUEST: .....

RESPONSE BY: _____ DATE: _____
(SIGNATURE AND TITLE) (day/month/year)

COPY TO: _____

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

SOIL SAMPLE LOG

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO.: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

SITE SAMPLE NO.	OFF-SITE LAB SAMPLE NO.	SOIL DESCRIPTION	SOURCE (LOCATION, DEPTH, ELEVATION)	MATERIAL TYPE	DATE (day/mo)	TEST METHODS	QA ID

NOTES: _____

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

NUCLEAR GAUGE STANDARD COUNT LOG (ASTM D 2922 & ASTM D 3017)

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year
NUCLEAR GAUGE MODEL: ____ SERIAL NO.: ____
DATE ARRIVED ON SITE: ____ DATE DEPART SITE: ____

DATE (day/mo)	MOISTURE COUNT	DENSITY COUNT	PASS/ FAIL	QA ID	DATE (day/mo)	MOISTURE COUNT	DENSITY COUNT	PASS/ FAIL	QA ID

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

FIELD NUCLEAR MOISTURE/DENSITY TEST LOG (ASTM D 3017 AND ASTM D 2922)

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO.: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

SPECIFICATION REQUIREMENTS

SOURCE: _____ MATERIAL TYPE: (CIRCLE ONE) FILL / SUBGRADE / SUBBASE / CLAY / OTHER: _____ LIFT THICKNESS (LOOSE/COMPACTED): ____

% COMPACTION: _____ MOISTURE RANGE: _____ ASTM D 698: A B C / ASTM D 1557: A B C (CIRCLE ONE) _____

NUCLEAR GAUGE TYPE: _____ NUCLEAR GAUGE SERIAL NO. _____ COR. FACTOR: _____

TEST NO.	TEST LOCATION	PROBE DEPTH/ ELEV/ LIFT NO.	LAB RESULTS		FIELD TEST RESULTS						RETEST NO.	QA ID
			OMC (%)	MAX DRY UNIT WT (PCF)	FMC (%)	WET UNIT WT (PCF)	DRY UNIT WT (PCF)	PERCENT COMPACT (%)	PASS	FAIL		

GeoSyntec Consultants

B S S C

BAILEY SITE SETTLORS COMMITTEE

LABORATORY TEST SUMMARY

PROJECT: BAILEY SUPERFUND SITE

LOCATION: ORANGE COUNTY, TEXAS PROJECT NO.: GE3913 TASK NO.: 610

DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

SOURCE: ____ MATERIAL TYPE: ____ QA ID: ____

NOTE: Separate forms are required for each material type and source. All samples must have a site sample number and be recorded on the soil sample log.

SITE SAMPLE NO.	GEL SAMPLE NO.	SAMPLE MOISTURE CONTENT ASTM D 2216 (%)	GRAIN SIZE			ATTERBURG LIMITS ASTM D 4318			SOIL CLASSIFICATION ASTM D 2487	LOI	CARBO CONT.	COMPACTION ASTM D 698 (or) ASTM D 1557		PERMEABILITY ASTM D 2434[1] (or) ASTM D 5084[2]			PASS/ FAIL	ACUMUL. QUANT. PLACED (APPROX)
			PASSING NO. 200 SIEVE ASTM D 1140 (%)	ASTM D 422 SIEVE	ASTM D 422 HYDR.	LL (%)	PL (%)	PI		ASTM C311 (%)	ASTM D3042 (%)	MAX. DRY UNIT WT. (pcf)	OPT. MOIST. CONT. (%)	DRY UNIT WT. (pcf)	MOIST. CONT. ASTM D 2216 (%)	HYDRAULIC COND'VITY (cm/sec)		(yd^3)

COMMENTS: ____

NOTES: (1) HYDRAULIC CONDUCTIVITY DETERMINED AT A HYDRAULIC GRADIENT OF ____.

(2) HYDRAULIC CONDUCTIVITY DETERMINED AT AN EFFECTIVE CONFINING STRESS OF ____.

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

MATERIAL INVENTORY

PROJECT: BAILEY SUPERFUND SITE

LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610

DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

PRODUCT TYPE: _____ MANUFACTURER: _____

INVENTORY DATE (day/mo)	BATCH / ROLL NO.	Q.A. CONFORMANCE			Q.C. DOCUMENTS			QA ID
		DATE SAMPLED (day/mo)	SAMPLE NO.	PASS/ FAIL	DATE RECEIVED (day/mo)	DATE CHECKED (day/mo)	PASS/ FAIL	

AVG. ROLL WIDTH: _____ AVG. ROLL LENGTH: _____

NUMBER OF ROLLS ABOVE: _____ ACCUMULATIVE NUMBER OF ROLLS: _____

CUMULATIVE AREA: _____ TOTAL NUMBER OF CONFORMANCE TESTS: _____

CERTIFICATE OF ACCEPTANCE
SUBGRADE SURFACE

INSTALLER	PROJECT
NAME: _____	NAME: _____
ADDRESS: _____	_____
_____	LOCATION: _____
_____	_____
INSTALLER AUTHORIZED REPRESENTATIVE: _____	_____
	OWNER: _____

I, The undersigned, duly authorized representive of _____ do hereby accept the surface on which the geosynthetics will be installed and shall be responsible for maintaining the suitability of this surface, in accordance with the project specifications. (i.e., The contractor shall not install the geosynthetics until the subgrade surface is acceptable. Installation of the geosynthetics will be considered acceptance of the subgrade.)

PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ _____

DATE	PANEL NOS.	SIGNATURE

GEOSYNTEC CONSULTANTS

B S S C
BAILEY SITE SETTLORS COMMITTEE

PANEL PLACEMENT LOG (WITHOUT TEMPERATURE)

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year
PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ PRODUCT TYPE: ____

PANEL NO.	BATCH / ROLL NO.	DATE (day/mo)	TIME	PLACEMENT LOCATION COMMENTS	APPROX WIDTH (ft)	APPROX LENGTH (ft)	QA ID
				TOTALS:(1)			

NOTE: (1) APPROXIMATE AREA: THIS PAGE: ____ (ft^2) ACCUMULATED: ____ (ft^2)
NOTES: ____

GEOSYNTEC CONSULTANTS

B S S C
BAILEY SITE SETTLORS COMMITTEE

TRIAL SEAM LOG - EXTRUSION (WITHOUT TEMPERATURE)

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year
CONTRACTOR: ____ TENSIOMETER DESCRIPTION: ____

TRIAL SEAM NO.	DATE (day/mo)	TIME	MACHINE NO.	OPER ID	(1) MATERIAL DESCRIPTION	EXTRUSION		TEST RESULTS				RE-TEST NO.	QA ID
						PREHEAT (SET/°C/°F)	BARREL (°C/°F)	PEEL (ppi/psi)	SHEAR (ppi/psi)	PASS	FAIL		

NOTE: (1) MATERIAL DESCRIPTION REFERS TO EITHER SMOOTH/SMOOTH (S/S); SMOOTH/TEXTURED (S/T); OR TEXTURED/TEXTURED (T/T).

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

TRIAL SEAM LOG - FUSION (WITHOUT TEMPERATURE)

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year
CONTRACTOR: ____ TENSIOMETER DESCRIPTION: ____

TRIAL SEAM NO.	DATE (day/mo)	TIME	MACHINE NO.	OPER ID	MATERIAL DESCRIPTION (1)	FUSION		TEST RESULTS			RETEST NO.	QA ID
						WEDGE (SET/°C/°F)	MEASURED SPEED (ft/min)	PEEL (ppi/psi) INSIDE	PEEL (ppi/psi) OUTSIDE	SHEAR (ppi/psi)	PASS/ FAIL	

NOTE: (1) MATERIAL DESCRIPTION REFERS TO EITHER SMOOTH/SMOOTH (S/S); SMOOTH/TEXTURED (S/T); OR TEXTURED/TEXTURED (T/T).

GEOSYNTEC CONSULTANTS

B S S C
BAILEY SITE SETTLORS COMMITTEE

PRODUCTION SEAM LOG (WITHOUT TEMPERATURE)

PROJECT: BAILEY SUPERFUND SITE

LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610

DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

CONTRACTOR: ____

PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ PRODUCT TYPE: ____

DATE (day/mo)	SEAM NO.	TIME	APPROX LENGTH (ft)	MACHINE NO.	OPERATOR ID	LOCATION COMMENTS	QA ID
		TOTAL (1)					

NOTE: (1) APPROXIMATE LENGTH: THIS PAGE ____ (ft) ACCUMULATED ____ (ft)

GEOSYNTEC CONSULTANTS

B S S C
BAILEY SITE SETTLORS COMMITTEE

SEAM AND PANEL REPAIR LOCATION LOG

PROJECT: BAILEY SUPERFUND SITE

LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610

DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

CONTRACTOR: _____

PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ PRODUCT TYPE: _____

NORTH

NOTE:
SEE OTHER SIDE FOR SYMBOLS

QA ID: _____

SEAM NO.:	
PANEL NO.:	
AVG PANEL LENGTH:	
AVG PANEL WIDTH:	
AREA: (ft^2)	

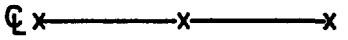
SYMBOLS

S11/P12 — SECONDARY/PRIMARY GEOMEMBRANE PANEL NUMBER

NDT = NONDESTRUCTIVE TEST

VT = VACUUM TEST

AT = AIR TEST


LEACHATE COLLECTION PIPE

TOE OF SLOPE

CREST OF SLOPE


ANCHOR TRENCH

EXTRUSION WELD

GEOGRID


GEONET

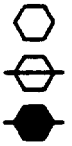
GEOTEXTILE


GEOCOMPOSITE LAYER


CAPPED SEAM (FUSION)


NDT TESTED


DESTRUCTIVE SAMPLE (DS) LOCATION
P=PRIMARY
S=SECONDARY


(FAILED)

(PASSED)

NDT TESTED


EXTRUSION WELD REPAIR


NDT TESTED

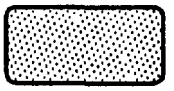

COUPON SAMPLE LOCATION


NDT TESTED


PATCH REPAIR LOCATION (EXTRUSION)


NDT TESTED


PIPE PENETRATION


SUMP AREA

THICKNESS MEASUREMENT


ADJACENT PANEL REFERENCE

GeoSyntec Consultants

BSSC
BAILEY SITE SETTLORS COMMITTEE

REPAIR SUMMARY LOG

PROJECT: BAILEY SUPERFUND SITE

LOCATION: ORANGE COUNTY, TEXAS PROJECT NO.: GE3913 TASK NO.: 610

DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year

PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ _____ CONTRACTOR: _____

DATE (day/mo)	REPAIR LOCATION		REPAIR NO. AND CODE (1)	REPAIR TYPE (2)	REPAIR			WELDER ID		QA ID	NON-DESTRUCTIVE TESTING				
	SEAM OR PANEL	MAPPING (DIST FROM 0-FT OR EDGE)			LENGTH (ft)	WIDTH (ft)	DIA (ft)	MACH NO.	OPER ID		DATE (day/mo)	OPER ID	PASS/ FAIL	ACTION	QA ID
(15)															

NOTES: (1) REPAIR NO.: REPAIRS CAN BE NUMBERED SEQUENTIALLY, IF NECESSARY.
(1) REPAIR CODES: P = PATCH, C = CAP, S= ANCHOR TRENCH EXTENSION (SKIRT), DS = DESTRUCTIVE SAMPLE, G = GRIND & WELD, T = TOPPING ALONG FUSION SEAM, R = RECONSTRUCTION
(2) REPAIR TYPES: E = EXTRUSION, F = FUSION

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

DESTRUCTIVE TEST LOG

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO.: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year
CONTRACTOR: ____ TEST REQUIREMENTS: ____
PRIMARY: ☐ SECONDARY: ☐ RE-TEST: ☐ OTHER: ☐ ____
DISTRIBUTION: LABORATORY: ☐ ARCHIVE: ☐ INSTALLER: ☐ OTHER: ☐

SAMPLE DATA					FIELD DATA					LABORATORY DATA						
D.S. NO.	SEAM/ LOCATION	MACH NO.	OPER ID	DATE SAMPLED/ SHIPPED (day/mo)	AVG PEEL (PPI/PSI) INSIDE	AVG PEEL (PPI/PSI) OUTSIDE	AVG SHEAR (PPI/PSI)	PASS/ FAIL	QA ID	DATE OF RESULTS (day/mo)	AVG PEEL (PPI/PSI) INSIDE	AVG PEEL (PPI/PSI) OUTSIDE	AVG SHEAR (PPI/PSI)	PASS/ FAIL	RE-TEST	QA ID
(15)																

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

NONDESTRUCTIVE TEST LOG

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO.: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year
CONTRACTOR: ____ TEST REQUIREMENTS: ____
PRIMARY: ☐ SECONDARY: ☐ RE-TEST: ☐ OTHER: ☐ ____

DATE (day/mo)	SEAM NO. OR LOCATION	LENGTH OF SEAM TESTED (ft)	OPER. ID	AIR PRESSURE TEST					VACUUM-BOX TEST		PASS/ FAIL	ACTION	QA ID
				START		Δ PRES. (psi)	STOP		NO. OF LEAKS	DATE OF RE-TEST			
				TIME	PRES.		PRES.	TIME					
(15)													

NOTES: ____

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

PANEL PLACEMENT LOG (WITH TEMPERATURE)

PROJECT: BAILEY SUPERFUND SITE
LOCATION: ORANGE COUNTY, TEXAS PROJECT NO: GE3913 TASK NO.: 610
DESCRIPTION: REVISED FINAL REMEDIATION DATE: ____ day ____ month 1996 year
PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ PRODUCT TYPE: ____

PANEL NO.	BATCH / ROLL NO.	DATE (day/mo)	TIME	TEMP[1] (°F / °C)	PLACEMENT LOCATION COMMENTS	APPROX WIDTH (ft)	APPROX LENGTH (ft)	QA ID
					TOTALS:[2]			

NOTES: (1) TEMP MEASUREMENT LOCATION: ____ (2) APPROX AREA: ____ (ft^2)

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

AIR PRESSURE TEST LOG

DATE: 1996 year

PROJECT: BAILEY SUPERFUND SITE PROJECT NO.: GE3913 TASK NO.: 610

LOCATION: _____

DATE	SEAM NO.	LOCATION	OPER. ID.	START TIME	PRES. (psi)	STOP TIME	PRES. (psi)	Δ PRES. (psi)	PASS/ FAIL	QA ID

COPY TO: _____ PER: _____

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

VACUUM TEST LOG

DATE: 1996 year

PROJECT: BAILEY SUPERFUND SITE PROJECT NO.: GE3913 TASK NO.: 610

LOCATION: _____

DATE	LOCATION	OPER. ID	NO. OF LEAKS	DATE RE-TESTED	PASS/ FAIL	QA ID

COPY TO: _____ PER: _____

GeoSyntec Consultants

B S S C
BAILEY SITE SETTLORS COMMITTEE

FIELD DESTRUCTIVE TEST LOG

DATE: 1996 year

PROJECT: BAILEY SUPERFUND SITE PROJECT NO.: GE3913 TASK NO.: 610

LOCATION: _____ CONTRACTOR: _____

PRIMARY: ☐ SECONDARY: ☐ OTHER: ☐ PRODUCT TYPE: _____

DATE	SAMPLE NO.	SEAM NO.	LOCATION	FIELD TEST RESULTS				LAB TEST RESULTS		ACTION	QA ID
				PEEL	SHEAR	PASS	FAIL	PASS	FAIL		

APPENDIX B

TABLE 02276-1
REQUIRED GEOSYNTHETIC CLAY LINER PROPERTY VALUES

TABLE 02276-1

REQUIRED GCL PROPERTY VALUES

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED[1] VALUES	TEST METHOD
GCL Properties				
Bentonite Content	minimum	lb/ft^2	1.0	ASTM D 5261
Hydraulic Conductivity (Bentonite)	minimum	cm/s	5×10^{-9}	GRI GCL-2
Bentonite Moisture Content	maximum	%	25	ASTM D 4643
Free Swell	minimum	ml/2g	24	ASTM D 5890
Thickness	minimum	mils	20	ASTM D 5199
Woven Geotextile[3]				
Mass Per Unit Area	minimum	oz/yd^2	3.0	ASTM D 5261
Grab Strength	minimum	lb	108	ASTM D 4632[2]
Tear Strength	minimum	lb	54	ASTM D 4533[2]
Puncture Strength	minimum	lb	54	ASTM D 4833
Mullen Burst Strength	minimum	psi	270	ASTM D 3786
Nonwoven Geotextile[3]				
Mass Per Unit Area	minimum	oz/yd^2	5.4	ASTM D 5261
Grab Strength	minimum	lb	135	ASTM D 4632[2]
Tear Strength	minimum	lb	54	ASTM D 4533[2]
Puncture Strength	minimum	lb	72	ASTM D 4833
Mullen Burst Strength	minimum	psi	250	ASTM D 3786

Notes:
1. All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table).
2. Minimum value measured in machine and cross machine direction.
3. GCLs not having these components and otherwise satisfying Part 2.01 of this Section, are exempt from meeting the specified values.

APPENDIX C

TABLE 02277-1
REQUIRED HDPE
GEOMEMBRANE PROPERTIES

AND

TABLE 02277-2
REQUIRED HDPE
GEOMEMBRANE SEAM PROPERTIES

TABLE 02277-1

REQUIRED HDPE GEOMEMBRANE PROPERTIES

Properties	Qualifiers	Units	Specified Values	Test Method
Physical Properties				
Thickness	average	mils	60	ASTM D 751
	minimum	mils	54	ASTM D 751
Specific Gravity	minimum	N/A	0.940	ASTM D 792 Method A or ASTM D 1505
Mechanical Properties				
Tensile Properties (each direction)				
1. Tensile Yield (force per unit width at yield)	minimum	lb/in	126	ASTM D 638[(1)]
2. Tensile Strength (force per unit width at break)	minimum	lb/in	225	ASTM D 638[(1)]
3. Elongation at Yield	minimum	%	12	ASTM D 638[(1)]
4. Elongation at Break	minimum	%	200	ASTM D 638[(1)]
Tear Resistance	minimum	lb	39	ASTM D 1004 Die C Puncture
Environmental Properties				
Carbon Black Content	range	%	2-3	ASTM D 1603[(1)]
Carbon Black Dispersion	N/A	none	Category 1 or 2	ASTM D 5596

Note: 1. Modified by NSF 54 Annex A.

TABLE 02277-2

REQUIRED HDPE GEOMEMBRANE SEAM PROPERTIES

Properties	Qualifiers	Units	Specified Values	Test Method
Shear Strength[1]				
fusion	minimum	lb/in	108	ASTM D 4437
extrusion	minimum	lb/in	108	ASTM D 4437
Peel Adhesion				
FTB[2]				
fusion	minimum	lb/in	85	ASTM D 4437
extrusion	minimum	lb/in	70	ASTM D 4437

Notes: 1. Also called "Bonded Seam Strength". Value is at material yield point.
2. FTB = Film Tear Bond. (Maximum 10 percent seam separation).

APPENDIX D

TABLE 02279-1
REQUIRED PROPERTY
VALUES FOR GEOCOMPOSITE

TABLE 02279-1

REQUIRED PROPERTY VALUES FOR GEOCOMPOSITE

PROPERTIES	QUALIFIER	SPECIFIED UNITS	TEST[1] VALUES	TEST METHOD
Geonet Component:				
Resin Density[(2)]	minimum	g/cc	0.935	ASTM D 1505
Carbon Black Content	range	%	2.0-3.0	ASTM D 1603
Thickness	minimum	mils	200	ASTM D 1777
Weight per Square Foot	minimum	lb/ft^2	0.16	ASTM D 2776 (Option C)
Geotextile Component:				
Mass per Unit Area	minimum	oz/yd^2	5.7	ASTM D 3776
Geotextile Filter Requirements				
Apparent Opening Size	maximum	mm	$O_{95} \leq 0.21$ mm	ASTM D 4751
Hydraulic Conductivity	minimum	$gal/min/ft^2$	110	ASTM D 4491
Mechanical Requirements				
Grab Strength	minimum	lb	160	ASTM D 1682[(3)]
Tear Strength	minimum	lb	60	ASTM D 1117[(3)]
Puncture Strength	minimum	lb	80	ASTM D 3787
Burst Strength	minimum	psi	275	ASTM D 3786

TABLE 02279-1 (Continued)

REQUIRED PROPERTY VALUES FOR GEOCOMPOSITE

PROPERTIES	QUALIFIER	SPECIFIED UNITS	TEST[1] VALUES	TEST METHOD
Geocomposite Drainage Layer:				
Transmissivity (one-sided)	minimum	gal/min/ft	23	ASTM D 4716[4]
Transmissivity (two-sided)	minimum	gal/min/ft	15	ASTM D 4716[4]
Peel Strength	minimum	gm/in	500	ASTM D 904

Notes:

(1) All values represent minimum average roll values (i.e., test results for samples collected from any roll in a lot should meet or exceed the values in this table), except as noted.
(2) The density of the net resin shall not exceed that of the geomembrane.
(3) Minimum of values measured in machine and cross machine directions with 1 inch clamp on Constant Rate of Extension (CRE) machine.
(4) Transmissivity shall be measured using water at 68°F (20°C) ±5°F (3°C) with gradients of 0.03 under a confining pressure of 250 lb/sf. The geocomposite shall be placed in the testing device between a smooth geomembrane liner and an overlying soil bedding layer. Measurements shall be taken one hour after application of confining pressure.

TABLE 02278-1

REQUIRED PROPERTY VALUES FOR GEOTEXTILE FILTER

PROPERTIES	QUALIFIER	UNIT	SPECIFIED[4] VALUES	TEST METHOD
Type				
Nonwoven needlepunched				(-)
Polymer composition	minimum	%	95 polypropylene or polyester by weight	(-)
Mass per unit area	minimum	oz/yd^2	7	ASTM D 5261
Filter Requirements				
Apparent opening size (O_{95})	maximum	mm	0.21	ASTM D 4751
Permittivity	minimum	sec^{-1}	0.5	ASTM D 4491
Mechanical Requirements				
Grab strength	minimum	lb	180	ASTM D 4632[1]
Tear strength	minimum	lb	75	ASTM D 4533[2]
Puncture strength	minimum	lb	75	ASTM D 4833[3]
Burst strength	minimum	psi	350	ASTM D 3786
Durability				
Ultraviolet Resistance	minimum	%	70	ASTM D 4355

Notes:

(1) Minimum of values measured in machine and cross machine directions with 1 inch clamp on Constant Rate of Extension (CRE) machine.
(2) Minimum value measured in machine and cross machine direction.
(3) Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
(4) All values represent minimum average roll values.

TABLE 02278-2

REQUIRED PROPERTY VALUES FOR SUPPLEMENTAL GEOTEXTILE CUSHION

PROPERTIES	QUALIFIER	UNITS	SPECIFIED[4] VALUES	TEST METHOD
Type				
Nonwoven needlepunched				(-)
Polymer composition	minimum	%	95 polypropylene or polyester by weight	(-)
Mass per unit area	minimum	oz/yd^2	16	ASTM D 5261
Mechanical Requirements				
Grab strength	minimum	lb	350	ASTM D 4632[1]
Tear strength	minimum	lb	120	ASTM D 4533[2]
Puncture strength	minimum	lb	180	ASTM D 4833[3]
Burst strength	minimum	psi	700	ASTM D 3786
Durability				
Ultraviolet Resistance	minimum	%	70	ASTM D 4355

Notes:

(1) Minimum of values measured in machine and cross machine directions with 1 inch clamp on Constant Rate of Extension (CRE) machine.
(2) Minimum value measured in machine and cross machine direction.
(3) Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
(4) All values represent minimum average roll values.